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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS.

FIELD OPERATIONS OF THE BUREAU OF SOILS,

1905.

[SEVENTH REPORT.]

BY

MILTON WHITNEY, Chief.

WITH

ACCOMPANYING PAPERS BY ASSISTANTS IN CHARGE OF FIELD PARTIES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

BUREAU OF SOILS.

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Albert G. Rice, *Chief Clerk.*
Charles H. Seaton, *Editor.*

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Frank D. Gardner, in charge of Soil Management.
George T. McNess, in charge of Tobacco Investigations.
Clarence W. Dorsey, in charge of Alkali Land Reclamation.
Oswald Schreiner, in charge of Fertility Investigations.
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---

[a] Resigned, 1905.
[b] Detailed to Cornell University.
[c] Temporarily assigned to Soil Survey.
[d] Transferred to Alkali Reclamation.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Soils,
Washington, D. C., November 13, 1905.

Sir: I have the honor to transmit herewith the manuscript report, with accompanying illustrations and maps, of the field operations of the Bureau of Soils in 1905, the publication of which is authorized by public resolution No. 9 of the Fifty-eighth Congress, second session.

Respectfully,

Milton Whitney,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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FIELD OPERATIONS OF THE BUREAU OF SOILS.

1905.

By MILTON WHITNEY, Chief.

GENERAL REVIEW OF THE WORK.

PROGRESS OF THE SURVEY.

At the close of the field season for the calendar year 1904 there had been surveyed 88,885 square miles, or 56,867,200 acres. The work carried on during the year ended December 31, 1905, increased the total number of square miles mapped to 110,087, or a total of 70,455,680 acres. The work for 1905 comprised 21,289 square miles, or 13,624,960 acres, a decrease of 7,155 square miles, or 4,579,200 acres, from the amount mapped in 1904. This decrease in the aggregate of work accomplished is due to a decrease in the amount of money and of the number of men available for field work. During the calendar year 1904, 20 field parties of two men each were maintained in the field, while in 1905 no more than 17 parties were available at any time, and during the winter only 12 parties could be kept in the field. In view of these circumstances the aggregate area covered has been satisfactory. During the year 10 areas begun in 1904 were completed and 45 additional areas undertaken, of which 35 were completed before the end of the year.

The average cost of the field work in 1905 was $2.66 per square mile, an increase of $0.23 per square mile over the average of 1904. This is largely due to the fact that with each year of experience attained by the field assistants greater detail can be employed in the mapping of soils. Some part of the increase was also due to very necessary increases in the salaries paid to the more experienced men.

It will be seen by the accompanying tables that by December 31, 1905, soil-survey work had been undertaken in all but three of the States, in four Territories, and also in Porto Rico. The soil survey of Rhode Island was completed in 1904, and in each of six States more than 5,000 square miles had been covered.

Areas surveyed and mapped and cost of field work, January 1 to December 31, 1905, inclusive.[a]

State or Territory.	Area.	Area surveyed.	Cost per square mile.	Total cost.
		Sq. miles.		
Alabama	Blount County[b]	287	$4.72	$1,354.50
	Dallas County	992	2.49	2,465.06
	Lauderdale County[b]	393	2.79	1,097.10
	Montgomery County[b]	442	2.29	1,011.22
Arkansas	Prairie County	43	3.14	135.00
California	Stockton[b]	434	4.56	1,979.04
Colorado	Grand Junction	168	8.35	1,403.34
Florida	Escambia County	87	3.07	267.43
	Leon County	675	4.00	2,701.00
Georgia	Spalding County	205	3.68	755.16
	Waycross	75	4.12	309.02
Indiana	Newton County	393	2.65	1,042.63
	Tippecanoe County	499	2.25	1,125.08
Indian Territory	Tishomingo	100	3.24	323.71
Kansas	Brown County[b]	195	2.02	393.97
Kentucky	Madison County	437	1.99	868.40
	McCracken County	242	2.45	594.36
Louisiana	Caddo Parish	29	7.97	231.16
	East Baton Rouge Parish	451	2.73	1,231.82
	Tangipahoa Parish[b]	560	2.29	1,280.68
Michigan	Oxford	210	4.43	929.00
Minnesota	Carlton[c]	413	2.70	1,115.26
Mississippi	Crystalsprings	231	5.10	1,178.98
	Montgomery County	35	7.30	255.67
	Pontotoc County	130	2.47	320.76
Missouri	Crawford County	747	1.86	1,391.37
	Scotland County	440	1.83	805.65
Montana	Gallatin Valley	325	4.24	1,378.86
Nebraska	Sarpy County	227	2.76	626.17
New York	Binghamton	229	1.82	417.26
	Tompkins County[b]	178	3.82	678.21
North Carolina	Duplin County[b]	484	2.05	992.32
	New Hanover County	174	3.10	539.50
	Perquimans and Pasquotank[b]	246	3.52	866.45
North Dakota	Carrington	720	2.36	[d]1,699.83
Ohio	Cleveland	509	2.51	1,280.88
	Westerville	476	1.80	856.24
Oklahoma	Oklahoma County	70	3.11	217.57
Pennsylvania	Chester County	760	2.29	1,736.94
	Montgomery County	496	3.24	1,608.67
South Carolina	Cherokee County	361	1.41	507.65
	York County	669	2.11	1,413.80
Tennessee	Henderson County	499	2.38	1,190.59
Texas	Houston County[b]	762	1.93	1,470.70
	Lavaca County	995	2.49	2,480.00
	Lee County	666	2.12	1,409.44
	Rusk County	75	5.05	378.82
	San Marcos	95	3.70	351.64
	Waco	495	2.47	1,225.00

[a] This includes the salaries of the men while in the area and their subsistence expenses, but not cost of transportation to and from the area.

[b] These figures do not include sections of these areas surveyed in preceding years.

[c] This area includes a few square miles in Wisconsin.

[d] Of this amount $353.16 was paid by the Agricultural and Economic Geological Survey of North Dakota.

Areas surveyed and mapped and cost of field work, January 1 to December 31, 1905, inclusive—Continued.

State or Territory.	Area.	Area surveyed.	Cost per square mile.	Total cost.
		Sq. miles.		
Virginia	Hanover County	475	$2.43	$1,154.35
	Louisa County	505	1.87	946.20
Washington	Island County	233	2.27	528.65
	Everett	525	3.02	1,583.92
West Virginia	Upshur County	330	2.53	835.46
Wisconsin	Portage County	797	2.29	1,825.64
Total		21,289	2.66	56,767.15

Areas surveyed during the year ending December 31, 1905, and areas previously reported.

State or Territory.	Work during 1905.	Work previously reported.	Total.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
Alabama	2,114	4,743	6,857	4,388,480
Arizona		859	859	549,760
Arkansas	43	877	920	588,800
California	434	6,162	6,596	4,221,440
Colorado	168	2,260	2,428	1,553,920
Connecticut		505	505	323,200
Delaware		314	314	200,960
Florida	762	1,033	1,795	1,148,800
Georgia	280	1,610	1,890	1,209,600
Idaho		1,135	1,135	726,400
Illinois		5,921	5,921	3,789,440
Indiana	892	1,728	2,620	1,676,800
Indian Territory	100		100	64,000
Iowa		2,303	2,303	1,473,920
Kansas	195	2,350	2,545	1,628,800
Kentucky	679	1,399	2,078	1,329,920
Louisiana	1,040	2,906	3,946	2,525,440
Maryland		2,610	2,610	1,670,400
Massachusetts		809	809	517,760
Michigan	210	3,078	3,288	2,104,320
Minnesota	413	256	669	428,160
Mississippi	396	2,669	3,065	1,961,600
Missouri	1,187	3,335	4,522	2,894,080
Montana	325	107	432	276,480
Nebraska	227	1,561	1,788	1,144,320
New Jersey		1,303	1,303	833,920
New Mexico		129	129	82,560
New York	407	3,195	3,602	2,305,280
North Carolina	904	5,837	6,741	4,314,240
North Dakota	720	1,499	2,219	1,420,160
Ohio	985	2,715	3,700	2,368,000
Oklahoma	70		70	44,800
Oregon		442	442	282,880
Pennsylvania	1,256	1,750	3,006	1,923,840
Porto Rico		330	330	211,200
Rhode Island		1,085	1,085	694,400
South Carolina	1,030	3,667	4,697	3,006,080

Areas surveyed during the year ended December 31, 1905, and areas previously reported—Continued.

State or Territory.	Work during 1905.	Work previously reported.	Total.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
South Dakota		484	484	309,760
Tennessee	499	2,770	3,269	2,092,160
Texas	3,088	4,969	8,057	5,156,480
Utah		1,501	1,501	960,640
Vermont		227	227	145,280
Virginia	980	4,132	5,112	3,271,680
Washington	758	510	1,268	811,520
West Virginia	330		330	211,200
Wisconsin	797	1,414	2,211	1,415,040
Wyoming		309	309	197,760
Total	21,289	88,798	110,087	70,455,680

REVIEW OF THE SURVEYS.

In Alabama 3 important areas upon which work was begun in 1904 were completed and 1 new area was surveyed. The surveys in Alabama show very diverse soil conditions existing under climatic surroundings of considerable range. The soil survey work of 1905 and of preceding years demonstrates that a considerably greater variety of crops might profitably be grown within the State. Soils well adapted to the production of corn, alfalfa, truck crops, tobacco, and apples and other fruits have been mapped and described in various reports. In connection with the later surveys interesting studies of the fertilizer requirements of several soil types have been made and these results are embodied in the present volume.

In Arkansas work was undertaken in the central part of the State in a region where rice culture is being profitably introduced. The survey of Prairie County was not completed in 1905, but will appear at a later date. Here also determinations of the fertilizer requirements of some of the principal soils were made.

In California the area around Stockton was completed, and will serve as a basis for the further extension of soil surveys through the important Tokay grape belt and in the region of the reclaimed marsh lands of the lower Sacramento Valley.

In Colorado an important fruit and general farming district around Grand Junction was surveyed.

In Florida the soil survey of Leon County was undertaken, particularly to ascertain upon what soils profitable tobacco production might be extended. Soils similar to those of Gadsden County, Fla., and Decatur County, Ga., were encountered, and upon some of these the growing of tobacco has been begun. Soils suitable to the production of truck and fruit crops were also mapped.

The agricultural experiment station of Georgia is located in Spalding County, and a survey of this area was deemed advisable. An area around Waycross was also begun. This region is passing from a turpentine and lumber producing region to one in which agricultural pursuits are becoming more important. Some long staple cotton is already produced, and the soils of the area are adapted to the growing of cotton, cane, and of various fruits and vegetables.

In Indiana two important areas were surveyed. In Newton County there are found extensive areas of peat, muck, and swamp, some of which have been drained and are producing cereal and grass crops. A considerable area of similar land still exists in an undrained condition. Much of this land might be utilized for the production of celery, onions, cabbages, and similar crops.

In Tippecanoe County a survey was made of a rich prairie section devoted to the production of corn, wheat, oats, and grass. The acreage planted to corn is steadily increasing, being 30 per cent greater than twenty years ago. The same is true of oats, while the acreage devoted to wheat has declined as steadily. The feeding of cattle is decreasing and a larger proportion of the corn and oat crops is sold at the elevator. The predominance of the soils of the Marshall series marks this county as a typical corn and oat producing region, but the great diversity of soils also renders it capable of supporting a much more varied agriculture than now exists.

Work was begun in the Indian Territory by a soil survey around Tishomingo. Cotton and corn are profitable staple crops both upon the upland and in the alluvial river bottoms. Fruit interests of considerable importance are being developed. The division of the Indian lands in severalty is stimulating the development of this region.

In Kansas the soils of Brown County were mapped. The region is one of general farming and stock raising. Dairying for butter production is being developed.

Two areas were surveyed in Kentucky. In McCracken County tobacco growing constitutes one of the chief interests. Greater diversification in crop production might well be introduced, although the soil of the county is remarkably uniform.

Madison County comprises a prominent stock raising and general farming area in the plateau region of eastern Kentucky. There is a considerable variety in the soils of the county, and corn, wheat, and grass are the chief crops, with tobacco and hemp of secondary importance. Farm products are largely fed to beef cattle. The question of destructive soil erosion is presented in some parts of the area.

In Louisiana work was undertaken in three parishes. In Tangipahoa Parish the soils of a very interesting trucking region were studied. Here cotton growing is becoming subordinate to berry and milk production and is now largely confined to the upland soils.

In East Baton Rouge a survey was made of an important cotton and cane producing region. Cotton is the chief crop, with corn second and cane third. Some rice is also grown. By thorough drainage considerable areas of valuable cotton and cane soils might be added to the agricultural resources of the parish. Even the upland soils would in many cases be benefited by drainage.

In Caddo Parish a survey was made to ascertain upon what types of soils the production of filler tobacco might be extended with the best prospects of success. Soils similar to those upon which filler tobacco has been grown successfully in Alabama and Texas were encountered. It was also found that upon certain soils alfalfa might profitably be grown.

In Michigan the Oakland area of 1904 was extended northward to the county line.

An important survey was made of the soils of the "cutover pine lands" of Carlton County, Minn. These lands are being used for the production of hay, oats, and potatoes, and a considerable extension of the production of the latter crop is possible.

In Mississippi the survey of the important truck-producing area around Crystalsprings was completed and surveys in Montgomery and Pontotoc counties were begun. In the former county quite a variety of soils was encountered, and upon these different soils agricultural interests might well be further diversified. In Pontotoc County the soils of the Pontotoc Ridge are well adapted to peach production, while other soils in the area can be further developed in the growing of staple crops. In the case of both of these counties determinations were made of the manurial requirements of the soils.

In Missouri a survey was made of the fruit region in the central part of the State, the work covering Crawford County, and in the stock and grain producing region of northern Missouri in Scotland County.

In Montana a survey was made of the irrigated lands in the Gallatin Valley.

In Nebraska the general farming and market-garden soils of Sarpy County were mapped. The location of this area near Omaha is bringing about a development of more specialized agriculture than is common in the prairie regions.

The survey of Tompkins County and the Binghamton area in New York practically completes a study of the soils of central New York from Lake Ontario southward to the Pennsylvania line. Not only is a great diversity of topography and climate found in the general region, but a great variety of soils also exists. Except upon the Ontario Plain there is little diversified or specialized agriculture, and considerable changes from the grass and grain producing agriculture of the more southern counties might well be made.

In North Carolina the work of the soil survey has extended the study of the cotton, tobacco, and truck soils of the seaboard counties into Duplin, New Hanover, Perquimans, and Pasquotank counties. In all of these counties are located considerable areas of land well adapted to fruit and to vegetable growing. Some of these lands are not now under cultivation, while others are devoted to cotton and to corn.

In North Dakota a survey was made of the soils of the Carrington area in continuance of the cooperative work with the North Dakota Agricultural and Economic Geological Survey.

In Ohio surveys were made around Cleveland and Westerville. In both areas a prosperous general agriculture dominates.

Work in Oklahoma was begun in Oklahoma County, a small part of which was covered in 1905. The report on the completed area will be published at a later date.

In Pennsylvania Chester and Montgomery counties were surveyed. In both counties a great variety of soils was found. In this region agricultural operations have been conducted for more than two hundred years. The soils of both counties under the general farming and stock-raising system followed are largely maintaining their crop-producing power. No great diversification in farm crops has yet taken place, though intensive farming and the production of some highly specialized crops have been begun.

The work in South Carolina was continued in York and Cherokee counties. In both areas cotton is the predominating crop, and in both the diversity among the soils points to the necessity for the introduction of more crops.

In Tennessee a survey was made of Henderson County. Cotton and corn constitute the chief crops, and hogs and cattle are raised to some extent. The lands of this area could be much increased in producing capacity by systematic crop rotation and by better methods of tillage. The fertilizer requirements of the principal soil type were determined.

A large amount of work was undertaken in Texas, owing in part to the fact that the invasion of the cotton boll weevil has made necessary the introduction of other important staple crops. In the counties surveyed soils were found adapted to a wide range of crops, including filler tobacco, alfalfa, various truck crops, and several kinds of fruits.

In Virginia the soils of the air-cured tobacco district of middle Virginia were studied in Hanover and Louisa counties. In both counties a considerable diversity of soils was found, and their crop adaptation and fertilizer requirements will be described in the reports upon these two areas.

Some of the soils of western Washington were surveyed in Island County and the Everett area. In both areas only a small part of the available agricultural land has been brought under cultivation, and the considerable variety of soils would indicate that a diverse and extensive agriculture might readily be developed.

Soil-survey work in West Virginia was begun in Upshur County. While quite a variety of soils was found, grazing and stock raising constitute the chief agricultural industry of the county.

A soil-survey of Portage County, Wis., showed the existence of many different soils. In one part of the county large areas of swamp land exist which are capable of drainage and agricultural development. The upland soils are adapted to the production of general farm crops, potatoes, and winter varieties of apples.

GENERAL SYNOPSIS.

In general, it may be said that the work of the season of 1905 has further emphasized that of preceding years in indicating the immensely varied soil and climatic resources of the agricultural domain of the country. Additional soil types adapted to the production of a great variety of crops have been described. Certain of the surveys have shown that over large areas a far greater variety in the cropping system should be introduced.

Some of the surveys point out the existence of considerable regions where the lands are wholly or partially unoccupied for farming pursuits, though well suited to the growing of a variety of crops. In particular, several areas have been mapped where lumbering operations are nearly or quite completed and the deforested lands are ready for agricultural development. These areas are found in the Western, North Central, and Southern States.

ADAPTATION OF SOILS TO CROPS.

The areas surveyed in 1905 will also be found to furnish many interesting examples of special adaptation of soils to crops, among which might be mentioned the soils of the Orangeburg series in Florida, Alabama, and Texas, adapted to tobacco production; the soils of the Norfolk and Portsmouth series in Virginia, North Carolina, Florida, and Texas, adapted to truck crops; the soils of the Clyde series in Michigan, adapted to sugar-beet growing; the Dunkirk series of Ohio and New York, adapted to grape and peach culture; the soils of the Marshall series of the prairie States, preeminently adapted to corn production; the soils of the Wabash series in Louisiana, which are not only excellent cotton soils, but which, under proper climatic conditions, constitute the best soils for the growing of sugar cane.

The surveys included in the report for the calendar year of 1905 thus present many important facts bearing upon the great agricultural and soil problems of the country.

MANURIAL REQUIREMENTS OF SOILS.

A new feature of the soil surveys consists of the presentation of the results of tests made to determine the manurial requirements of the more important types. In these cases large samples of soils were collected and sent to the Bureau for testing by the wire-basket method. These large samples were subdivided and different kinds of fertilizing materials, including barnyard manure, chemical fertilizers, and green crops, were applied in various quantities and in different combinations. Upon the different samples thus treated wheat plants were grown and their growth compared with that of similar plants grown upon untreated check samples. The soil survey reports give the results of these determinations. This testing of manurial and fertilizer requirements will be continued on all the principal types and classes of soils in the regions where the use of fertilizers or manure is common or is being introduced. In this way the soil survey reports will not only deal with the appropriate selection of characteristic soils for the production of different farm crops, but will also indicate the proper procedure whereby increased yields of the staple crops may be secured. These two problems, adaptation of soil to crop and the maintenance and increase of crop yields, constitute the great agricultural problems of the country.

COOPERATION WITH OTHER ORGANIZATIONS.

During the year the work of the soil survey has been placed in even closer touch with that of the agricultural colleges and experiment stations of the different States. It is coming to be generally recognized that the soil surveys are very helpful to the farmers of any State, in that they enable the most accurate application of the results of experiments in crop production carried on by the stations. Not only are the maps of the various areas of use in showing where similar results may be obtained with the great staple crops under similar methods of treatment, but in several instances requests have been complied with involving the preparation of large-sized soil charts of the experiment station farms. These large charts serve to show the actual soil types found upon the experiment farms and all the details of their local modifications or phases, and they serve also as a basis for the correlation of soils in other sections of the State with those found upon the experiment farms.

Direct cooperation between the Bureau of Soils and several of the stations in the preparation of soil maps has been continued. An indirect form of cooperation, whereby many valuable suggestions and a large amount of information is secured from the scientific staff of the stations, has also been secured in many instances. In each case appropriate acknowledgment is made in the reports.

SOIL SURVEY OF TOMPKINS COUNTY, NEW YORK.

By JAY A. BONSTEEL, ELMER O. FIPPIN, and WILLIAM T. CARTER, Jr.

LOCATION AND BOUNDARIES OF THE AREA.

Tompkins County, N. Y., is located in the west-central part of the State, in what is known as the Finger Lake region. The county is nearly rectangular in outline, and comprises a total land surface of 315,264 acres, or about 492 square miles. It lies between the latitude 42° 17′ and 42° 18′ north, and between the meridians 76° 15′ 28″ and 76° 41′ 42″. Cayuga Lake extends diagonally into the northwestern part of the county, and at its head is situated the city of Ithaca, with a population of about 14,000. Cornell University and the Cornell College of Agriculture and Experiment Station are located at this place. The other principal towns of Tompkins County are Dryden, Groton, and Trumansburg.

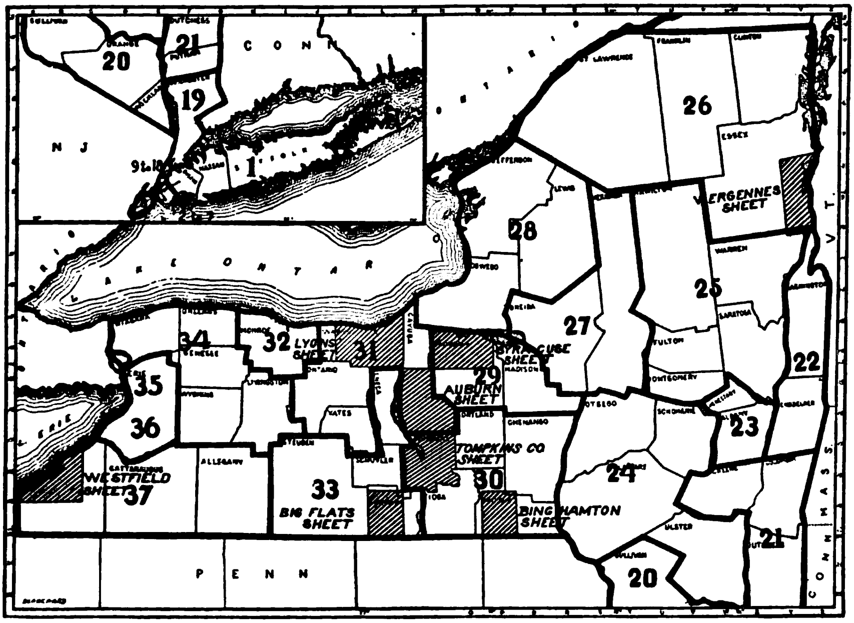

FIG. 1.—Sketch map showing location of the Tompkins County area, New York.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The attention of settlers was first drawn to this part of New York State through the expedition under General Sullivan in 1778–79. A portion of Sullivan's force camped near Ithaca, and upon their return the soldiers of this force carried back descriptions of the central New York region. Very few settlements were made in this part of the State before the year 1800. The lands of this section were ceded to the State of New York in 1789 by the Iroquois, and a part of the territory, known as the "military tract," was soon opened to settlement. This tract was laid out in townships of 100 lots, containing 600 acres each. All of Tompkins County, except the three southern townships, were included in this military tract.

During the colonial history of New York State, Tompkins County was a portion of Albany County. By later subdivisions it became a part of Tryon, and then of Montgomery. On April 17, 1817, Tompkins County was erected from Cayuga and Seneca counties. As then constituted, it consisted of the towns of Hector, Ulysses, and Covert from Seneca, and Dryden, Locke, and Genoa from Cayuga. In 1882 the towns of Danby, Caroline, and Cayute, now called Newfield, were annexed from Tioga County. In 1853 a part of the town of Newfield was annexed to Chemung County. In 1854 the town of Hector was made a part of Schuyler County. At the present time Tompkins County is made up of Caroline, Danby, Dryden, Enfield, Groton, Lansing, Ithaca, Newfield, and Ulysses townships.

The first white settlers in Tompkins County consisted of a group of 11 men who left Kingston, N. Y., in 1788. In 1789 three members of this group finally settled upon a lot of 400 acres located within the present site of Ithaca. At this time Tompkins County, with the exception of a few Indian fields, was heavily covered with great forest trees. The remaining townships of Tompkins County received their first settlements between 1791 and 1804. The first duty of these settlers was to cut roads through the dense forests to connect them with the earlier-settled portions of the State. The first road of this character to reach completion extended from Oxford, Chenango County, through Dryden Village, Etna, and Varna, to Ithaca. The forests of the county furnished an excellent opportunity for lumber operations, and sawmills, which were established at an early day, served the double purpose of furnishing a salable lumber product and at the same time of aiding in clearing the land for agricultural purposes. White pine constituted a considerable proportion of the upland forests, some hemlock existed and considerable hardwood, including maple, oak, beech, and chestnut. During the early stages of the development of Tompkins County corn and wheat were the crops most generally grown. Potatoes were introduced by John Yaples, who "traveled on foot 160 miles to a point on the Delaware, where he obtained 3 pecks of potatoes—eyes or sprouts—and returned carrying them in a sack upon his shoulders." Later large quantities of hay were produced in connection with wheat and corn, and Tompkins County still remains an important hay and grain growing region.

All of the earlier settlers as soon as possible planted fruit trees, and many old orchards still survive. Within recent years grapes, peaches, pears, and similar fruits have been planted to a considerable extent, especially along the slopes from the upland down to Cayuga Lake. At the present time grass constitutes the chief crop in respect to acreage. Oats, wheat, corn, and buckwheat follow in the order named.

CLIMATE.

In general the climate of Tompkins County is that characteristic of central and western New York, although the range of temperature is somewhat less than in other parts of the region. The snowfall is also said to be lighter than in surrounding counties. The prevailing northwest air currents in winter carry the evaporation from the surface of Lake Ontario—the waters of which are very deep and seldom freeze—over the region east of Tompkins County, where it is precipitated as snow.

There is but one Weather Bureau station in Tompkins County, and this is situated at Ithaca and therefore within the local influence of Lake Cayuga. There are probably some slight differences in the conditions found here and in parts of the county more remote from the lake, but the figures given in the following table doubtless represent with fair accuracy the general characteristics of temperature and precipitation in the county at large. The figures are normals, based on records covering a long period of years.

Normal monthly and annual temperature and precipitation.

Month.	Ithaca.		Waverly.		Month.	Ithaca.		Waverly.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	° *F.*	*In.*	° *F.*	*In.*		° *F.*	*In.*	° *F.*	*In.*
January	24.8	2.09	23.6	2.24	August	67.9	3.43	67.4	3.61
February	24.6	2.00	24.4	2.05	September	61.3	2.97	61.5	3.02
March	31.5	2.51	32.2	2.66	October	50.1	3.13	49.7	3.13
April	44.7	2.18	45.5	2.39	November	38.5	2.63	38.6	2.58
May	57.8	3.73	57.8	3.40	December	29.4	2.49	28.5	2.52
June	66.4	3.65	66.5	3.46	Year	47.1	34.57	47.2	34.94
July	70.8	3.76	70.8	3.88					

Based upon records kept at Ithaca, covering a period of twenty-five years, from 1879 to 1903, inclusive, the average date of last killing frost in spring is May 2 and of the first in fall, October 11. The average number of days between killing frosts, or in other words the average length of the growing season for all but the winter crops, is 132 days. The following table will show the variation from these averages:

Dates of first and last killing frosts.

Year.	Ithaca.		Year.	Ithaca.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1883	May 14	Oct. 5	1894	May 29	Sept. 28
1884	May 29	Oct. 10	1895	May 22	Sept. 15
1885	May 12	Oct. 8	1896	Apr. 9	Oct. 10
1886	Apr. 9	Oct. 16	1897	Apr. 27	Oct. 18
1887	Apr. 25	Oct. 15	1898	Apr. 22	Oct. 17
1888	May 3	Oct. 15	1899	Apr. 17	Oct. 3
1889	Apr. 23	Oct. 16	1900	May 3	Oct. 20
1890	May 2	Sept. 25	1901	Apr. 1	Oct. 28
1891	May 6	Oct. 12	1902	May 10	Oct. 10
1892	Apr. 26	Oct. 22	1903	May 2	Oct. 25
1893	Apr. 26	Oct. 16			

PHYSIOGRAPHY AND GEOLOGY.

Tompkins County constitutes a portion of the Allegheny Plateau. Its highest elevations are found in the southern part of the county in Dryden and Caroline and Newfield townships, where the highest hills rise to 1,900 and 2,000 feet above sea level. The topography of all of the county lying south of Dryden, Ithaca, and Enfield Center is very hilly. The tops of the hills are usually only gently rolling to nearly level, but the bordering slopes to the deeply-cut stream valleys are steeper and even precipitous. North of the line mentioned the upland portion of the county is more gently rolling, but is also cut by several deep stream valleys like those of Salmon and Owasco creeks. Cayuga Lake occupies a deep gorge in the northwestern part of the county and receives the stream drainage of the greater proportion of the area. The descents to this lake on all sides are very steep, being as great as 400 feet in the mile. The surface of the lake lies at an elevation of 381 feet above tide water. The waters of Cayuga Lake flow into Lake Ontario.

The underlying consolidated rocks of Tompkins County consist of shales and sandstones of the Portage and Chemung groups. These are rather thin bedded and are easily broken up when exposed to surface weathering. The Tully limestone outcrops near lake level along both shores of Cayuga Lake. Through the shales and sandstone of the region the streams, abounding in many small water falls, have cut deep gorges, particularly in the vicinity of Cayuga Lake.

The soils of Tompkins County, while influenced by the underlying rock, are more directly traceable in their origin to the action of the great continental glacier which swept over all of the northern part of the United States in recent geological times. This ice sheet, descending from the north, occupied the country to the depth of 2,000 feet or more. During this time the shale and sandstone rocks of the region in many instances were eroded and the surface material thoroughly ground up. With this finely ground material was deposited later a considerable amount of finely ground rock material brought in from regions of the north. The upland soils of the region are thus formed from the local material modified in varying degrees by material brought in from outside the county. At the time when the ice sheet receded many of the natural drainage outlets were dammed by the ice front and the drainage of the county was forced southward through the Sixmile Creek Valley and the Danby Valley into the Susquehanna system. While the drainage was being forced southward across these higher passes, considerable bodies of water were penned in between the ice front and the low divides across which the water flowed, forming local glacial lakes within whose waters sediments from the upland were deposited. Later, when the ice had withdrawn from the Mohawk and St. Lawrence drainage systems, the present outlets for the Tompkins County drainage were opened and the waters receded to their present position, leaving as evidence of their former existence many small upland swamps and extensive sedimentary deposits of various kinds. During the recession of the ice it halted at various places, and the débris carried within and on the ice was dumped in long, narrow ridges called "moraines."

As a result of the glaciation of Tompkins County, the material spread over the surface, which now constitutes the soils, may be divided into four groups. All of the southern and southeastern portion of the county, which was but feebly glaciated, is occupied by loam, shale, and clay soils, formed in part from the grinding up of the local rock and to a much less degree from the addition of deposited glacial material. The lower plateau soils contain a considerably higher proportion of material brought in from outside the district. Throughout both regions there are numerous morainal dumps, which give rise to stony and gravelly soils. In Dryden Valley near Dryden Lake, Freeville, Etna, Groton, and in the vicinity of McLean there is a series of glacial lake sediments consisting of higher lying materials, which are sandy and gravelly, and if lower-lying heavy loams and clays deposited in deeper water. The same is true of a considerable proportion of the valley extending from Ithaca down Sixmile Creek to the vicinity of Brookton, Slaterville Springs, and Caroline. Another series of deposits of this character occupies both sides of Cayuga Lake from water level to an elevation of about 1,000 feet. These deposits extend to about the same elevation along the sides of Salmon Creek gorge and turn westward along the valleys of Taghanic and Trumansburg creeks, where they extend out of the county into Schuyler and Seneca counties. All of the broader stream valleys are bordered by small deposits of gravelly loam and clay of an alluvial origin. The larger deposits of this character occur between Buttermilk Valley and Cayuga Lake in the Cayuga inlet valley. Along the margin of all the large valleys there are local accumulations of shale and of upland soil which have been washed down through the action of torrential streams and spread out in low flat cones. This material is also of an origin more recent than the period of glaciation. In the northern part of Tompkins County is a single soil type, Miami stony loam, which represents to a marked degree the material brought into Tompkins County through the glacial occupation of the region. Throughout this soil type in both surface soil and subsoil is scattered a considerable quantity of limestone gravel and some limestone bowlders. The fine dirt of the soil also contains finely divided lime rock. While several other soils of the region contain a large proportion of finely divided limestone, the Miami stony loam is most marked by its occurrence.

In several places in Tompkins County there are some small areas in which the covering of glacial soil is almost or entirely lacking. Where the underlying formation is sandstone the rock is usually found outcropping, but along both shores of Cayuga Lake a soft shale is found, which under the influence of frost and rain forms local areas of residual soil, only a few acres in extent and interesting chiefly for their geological significance.

SOILS.

Owing to the different methods by which the soils of Tompkins County have been formed the various types fall into certain groups which are known as soil series. In each series the proper or geographical name indicates the relationship and origin, while the descriptive name shows the texture or physical character of the type. The soils, chiefly of glacial origin, are included in the Volusia series.

The soils of the Volusia series consist of the débris of sandstone and shale, derived from the consolidated underlying material of the Upper Devonian rocks of central New York and northern Pennsylvania, mingled with varying quantities of glacial material brought in from other regions. With these soils are others derived from the glacial dumps known as " moraines." The series is marked throughout by the presence of a considerable quantity of shale and sandstone fragments, varying in size from small chips the size of a 10-cent piece to large platelike fragments a foot or more in breadth and about an inch thick. This series of soils is found throughout all of southern New York, northern Pennsylvania, and northeastern Ohio, occupying the elevated and deeply gorged Allegheny Plateau country along the southern limits of glacial action.

The Miami series, which is so extensively developed in more northern and western parts of the glacial region, is represented by only one type, Miami stony loam. This series differs from the Volusia in showing a larger percentage of limestone, gneiss, and other rocks of foreign origin brought by the ice from more northern areas.

The soils, consisting of material from the glaciated uplands, which, at the end of the glacial period, were washed down in local temporary lakes and ponds and redeposited as glacial lake or stream terraces, have been included in the Dunkirk series. As these lakes have become completely or partially drained their deposits have formed agricultural soils.

The Wabash series of dark-colored recent alluvial soils is represented by the Wabash loam.

There are some local soil formations which are also given descriptive names.

The following table gives the name and area of the several types:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Volusia loam	91,828	29.0	Dunkirk clay loam	7,552	..4
Volusia silt loam	78,912	25.1	Miami stony loam	7,488	2.3
Dunkirk stony clay	30,976	9.8	Volusia clay loam	5,952	1.9
Rough stony land	17,856	5.6	Volusia gravelly loam	4.608	1.5
Dunkirk gravelly loam	14,528	4.6	Wabash loam	4,352	1.4
Volusia stony loam	12,352	3.9	Dunkirk shale loam	4,224	1.3
Dunkirk gravelly sandy loam	12,032	3.8	Dunkirk fine sandy loam	1,600	.5
Dunkirk loam	12,032	3.8	Dunkirk silt loam	1,344	.4
Meadow	8,128	2.6	Total	315,264	....

VOLUSIA GRAVELLY LOAM.

The surface soil of the Volusia gravelly loam, to the average depth of about 10 inches, consists of a light-brown friable loam containing a large proportion of shale chips and some rounded gravel. The subsoil is a yellow or dark-gray gravelly sandy loam, in depressions approaching a clay, and in other places becoming much more sandy. In some cases the sand of the subsoil varies considerably within a single field. This is due to the presence of sand deposits within the material from which the soil is derived.

Volusia gravelly loam occurs largely within the valleys among the high hills in southern Tompkins County. It is derived from the sandy and gravelly morainal deposits, and the topography is consequently rather rough. The soil is well drained, and except for its rough topography is not difficult to till. Its occurrence in small areas makes it difficult to specify any crops to which it is particularly well adapted. Among the grain crops corn is grown to advantage on account of the fact that this soil is well drained and warm. When Volusia gravelly loam occurs in small areas it is used on many farms in Tompkins County for apple orchards. The excellent drainage of the type renders it particularly adaptable for such purposes. Grass, oats, corn, buckwheat, potatoes, and beans are also grown on this type, producing about the average yields for Tompkins County. Except for its limited occurrence this soil would be one of the most valuable corn soils in the county, not so much on account of the large size of the crops which are produced as because of the fact that corn is matured upon it nearly every season.

VOLUSIA CLAY LOAM.

The soil to a depth of 6 or 8 inches is a heavy loam or clay loam of a dark-yellow or brown color. The subsoil is a pale-yellow or drab clay loam, which is decidedly clayey in texture in local areas of naturally poor drainage. The soil and subsoil contain from 5 to 15 per cent of shale chips with but few large pieces. Large foreign bowlders may be observed, but are not abundant. The deep subsoil in fresh cuts is a dark-blue color and contains moderate amounts of shale and occasional large erratic bowlders.

The type occurs in the southwestern part of the county in the towns of Enfield and Newfield, between the elevations of 1,100 and about 1,600 feet and almost entirely on northern and northeastern slopes. The topographic features are not rough, but the surface of all of the areas has a marked slope. In but few instances is this sufficient to interfere seriously with cultivation.

The natural slope of the surface aids in drainage over most of the areas, but the soil is sufficiently fine textured and dense to prevent the rapid movement of water through it, and where the surface is fairly level, as in a few places, the drainage is defective. Much of the type would be benefited by underdrainage.

This type of soil has been formed by glacial action similar to that which has formed the Volusia silt loam and the Miami stony loam, and it is not clear why the material in these areas should be of a finer texture than the areas of soil adjoining it on the uplands. It may have been influenced by the lake conditions which formed the Dunkirk soils. In one place it shows a distinct relation to the Dunkirk clay loam. This is in the valley a half mile northwest of Enfield Falls at an elevation of about 1,050 feet, where cuts of stratified Dunkirk clay may be observed. In this place the clay is covered by a stony clay loam deposit and the material might be classed with the Dunkirk stony clay type if it were of greater extent. Deep cuts of till are exposed a half mile farther up Fivemile Creek.

Field practices indicate that the type is best suited to fine-rooted crops like the grasses. Wheat, oats, rye, and timothy do best, and corn not so well. Clover grows well in the summer months, but owing to the poor drainage of much of this soil it is "heaved" seriously in winter, so that the crop has been short lived. Some good growths of timothy and clover were observed on this type. Alfalfa is being tried, but thus far the success has been indifferent, probably because of poor drainage conditions. A small field of 1905 seeding, which had been inoculated, was looking very well when ready for the first cutting in the early part of August.

The farms on this type of soil are mostly in good condition, and on the average are much better than those on the Volusia silt loam with which it joins on the south.

Drainage, deep plowing, and the generous use of green and barn manures in connection with about 1,500 pounds of lime once in four or five years will probably give best results on this type of soil.

VOLUSIA SILT LOAM.[a]

The soil of the Volusia silt loam to an average depth of 8 inches is a light-brown to yellow silt loam. The subsoil from this depth to a depth of 36 inches is a light lemon-yellow, light-gray, or mottled gray and yellow soft silty loam. Both the soil and subsoil contain a large amount of flat, slaty, angular fragments of shale from several inches to a foot or more in breadth and length. In addition, both the soil and subsoil contain a considerable quantity of very finely divided shale fragments, locally known as shale gravel. The presence of these stones, both of large and small size, tends to make the soil appear of somewhat lighter texture than it really is. They materially aid in the drainage of the type. Over a considerable part of the area occupied by the Volusia silt loam rock is present beneath the subsoil at a depth of from 18 inches to 3 or 4 feet. Occasionally the depth of soil and subsoil reaches 12 or 15 feet in areas where small moraines have been formed.

The surface of the Volusia silt loam is hilly to rolling. The type occupies the more gently rolling or flattened tops of the high elevations in the southern part of the county, and also extends down the sides of many of the steeper hills. The natural drainage is fair, but many springs break out from crevices in the rocks and form small swampy areas an acre or more in extent. These have not been separated from the main body of the type.

The Volusia silt loam in the early days supported a growth of oak and chestnut on the higher ridges, white pine upon the more level areas, and a thick growth of hemlock along the steeper slopes and in the gorges. The greater part of this timber was long ago cut off, and only a few scattered patches of woodland remain upon the slopes, which in general are too steep for cultivation. Other steep slopes are used for pasture.

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[a] This type was first mapped in the Bigflats area, Chemung County, N. Y., where it was called the Hagerstown shale loam. Upon a further study of the general region the present classification of this type has been found necessary. The change is one in type name only, and is made to show the true relationship of this soil to other soils of the region.

Owing to its peculiarities of texture and its occurrence at a considerable elevation, the Volusia silt loam in Tompkins County is best adapted to the production of grass, oats, and buckwheat. Among the grasses, timothy, redtop, and bluegrass are grown to best advantage. The type is not particularly esteemed for the production of clover. In the Tompkins County area it is generally recognized as peculiarly adapted to the production of Irish potatoes. In many instances farmers reported that "the yellow loam soil on the hills was the best and surest potato soil in Tompkins County," and the wholesale and retail grocers in Ithaca also reported the best grade of potatoes as being grown in the townships where this type predominates.

On account of its position, lying from 1,000 to 2,000 feet above sea level, the Volusia silt loam does not constitute a corn soil in Tompkins County. In favorable seasons, when frost is not experienced until a late date, good yields are secured. The growing season is usually so short that considerable risk attends corn production on the type, especially where a yield of grain is desired. It would be possible for farmers to produce the short-season varieties of corn for ensilage. As a rule the cornfields in the region of the Volusia silt loam are of limited extent, not more than 2 or 3 acres on the majority of farms.

The Volusia silt loam produces an average yield of a scant ton of hay per acre; 12 to 20 bushels of buckwheat; 25 to 30 bushels of oats, and 80 to 125 bushels of Irish potatoes without spraying and with very meager care.

The type should be used for cattle and sheep production in order to utilize its known capabilities for the production of hay and oats. Turnips can also be grown. For a "money crop" buckwheat or potatoes are best suited to this type. In this connection it is well to hold in mind that partially rotted buckwheat straw plowed in before a potato crop is planted largely improves both the quantity and quality of the crop.

The location of the Volusia silt loam, where transportation by wagon is rather difficult, makes the raising of cattle and sheep a more promising line than the growing of bulky grain products or hay, which must be hauled to market at considerable expense.

The Volusia silt loam where the depth of surface soil and subsoil is 3 feet or greater, and where drainage is also good, is well suited to the production of winter apples like the Baldwin, Spitzenberg, and Greening. Many small and poorly cared for orchards furnish proof that modern systematic orcharding on a commercial scale would prove profitable. The difficulty of hauling out the apples when grown and packed would be the only great drawback.

The following table gives the average results of mechanical analyses of the fine earth of both the surface soil and subsoil:

Mechanical analyses of Volusia silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11277, 12284, 13315, 13317.	Soil	2.1	3.6	1.5	3.4	7.2	54.1	27.6
12278, 12285, 13316, 13318.	Subsoil	3.7	4.8	1.8	3.7	7.0	50.6	28.2

In order to obtain an idea of the manurial requirements of this type a large sample was collected about 3 miles east of Ithaca. The soil here is a brown silt loam containing about 25 per cent of shale fragment, and has a depth of 10 inches. The field from which the sample was taken has been in cultivation for fully a hundred years and is now in rather poor condition. Grass, oats, and potatoes have been the chief crops, and now yield an average of 1 to 2 tons of hay, 50 to 70 bushels of oats, and 30 to 50 bushels of potatoes per acre. Stable manure is used in small to medium applications, but no other fertilizers are employed.

The results of the examination of this sample by the wire-basket method indicate that stable manure produces a marked beneficial effect in increasing the productiveness of this soil; that sulphate of potash, alone or in combination, produces a fair increase; that nitrate of soda, acid phosphate, and lime, either alone or in various combinations, had little effect.

These results are held to be strictly applicable only to the field from which the sample was taken, but the use of stable manure is of recognized value in this area, and potash may be equally valuable on other farms on this type that are in similar condition. These results are also in accordance with the best farm practice and with actual field results.

VOLUSIA LOAM.

The surface soil of the Volusia loam to an average depth of 8 inches is a soft, slightly gritty loam, usually of a brown color when moist and of an ashy or yellow color when dry. The subsoil from 8 to about 24 inches is a pale-yellow loam. Below 24 inches the subsoil frequently contains a considerable quantity of very finely divided shale fragments, which gives it a somewhat gritty or sandy feel. In areas where the soil has been plowed in a wet condition and to about the same depth year after year a " hardpan " is frequently developed at the depth at which the plow sole travels. Like all the soils of this series the Volusia loam contains a considerable proportion of flat slaty shale and sandstone, and the same rock more finely divided is present in such quantities that the soil is locally known as "black gravel " soil.

In Tompkins County the Volusia loam occupies the gently rolling to hilly plateau country of the northern townships, lying at an elevation of 1,000 to 1,700 feet above sea level. The greater part of the type is fairly well drained naturally, but depressed areas, extremely level tracts, and portions of the type where the soil is underlain at shallow depths by impervious rock are frequently poorly drained. This lack of drainage is shown by the presence of stagnant water during spring and fall, by the growth of water-loving grasses, and in the soil itself by a mottled gray and yellow appearance of the subsoil.

The Volusia loam is in general cleared and cultivated to various farm crops. Of these hay, oats, buckwheat, corn, rye, and a little barley occupy the chief acreage. Upon the Volusia loam in Tompkins County the usual farm practice includes corn or buckwheat, oats or wheat, and then hay for three to five years in the rotation. When handled to the best advantage, and particularly when stable manure is used, the Volusia loam produces about 1 to 1¼ tons of hay per acre, 25 to 35 bushels of shelled corn, 30 to 40 bushels of oats, 12 to 18 bushels of buckwheat, about 18 bushels of barley, and 85 to 125 bushels of potatoes. Corn is a more certain crop than on the Volusia silt loam, and potatoes are not produced to as good advantage as upon that soil.

Numerous small orchards of apples are found on the Volusia loam. Those which are well cared for produce good fruit in satisfactory quantities. Apple orcharding is, however, entirely a subordinate interest. The production of hay, of oats, and of buckwheat to less extent are the principal purposes to which the type is put. In the northeastern portion of the county a considerable dairy industry has become established, chiefly on this type. The farms in this region are usually in a high state of cultivation, well improved with good buildings, and well cared for and pleasing in appearance. Land values are correspondingly high, and very little complaint is made of "worn-out" or unproductive soils. Such a condition can be attained upon this type in other parts of Tompkins County, provided the grains and grasses are devoted to stock feeding and the resulting resources in stable manure are carefully husbanded and used.

The following table shows the average texture of this soil:

Mechanical analyses of Volusia loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11283, 12288, 12290.	Soil	3.5	5.1	2.9	9.8	9.5	42.7	26.5
11284, 12289, 12291.	Subsoil	3.6	5.9	3.3	10.5	8.6	43.8	24.1

The manurial requirements of this type were investigated in the laboratory, using a large sample collected about 5 miles south of Ithaca. The field from which the sample was taken was typical of this soil. It had been in cultivation for eighty to one hundred years. The crops are grass, corn, oats, and potatoes. An average yield of 1½ tons of hay, 40 bushels of oats, and 100 bushels of potatoes per acre is secured. Corn in favorable seasons yields well—80 bushels of corn in the ear per acre in 1905. Little stable manure and no other fertilizers are used and the farm is badly run down.

The result of the examination of this sample by the wire-basket method indicates that stable manure produces a large increase in the productiveness of the soil; that nitrate of soda and sulphate of potash alone gave a slight increase, while in combination they produced a marked beneficial effect; and that phosphate alone or in combination had little effect. Green manure and lime had a moderate effect and lime alone gave only a slight increase. Indications point to the conclusion that, on this run-down farm, in addition to stable manure, complete fertilizers with lime and green manures with lime could be used to marked advantage.

These results are held to apply only to the field from which the sample was taken, but the beneficial effect of manure agrees with the general practice on the type in this locality. The effect of mineral fertilizers might not be so marked on farms in a better state of productiveness.

VOLUSIA STONY LOAM.

The Volusia stony loam, to a depth of about 8 inches, consists of a heavy dark-brown loam containing a large quantity of flat shale and also a considerable proportion of rounded stones or cobbles. The subsoil, extending from 8 inches to 36 inches, is made up of a light loam or in many instances of a somewhat sandy loam containing large amounts of stone and gravel. The subsoil is so stony that great difficulty was encountered in making borings to a depth greater than 12 or 18 inches.

The Volusia stony loam occupies long slopes reaching from the valleys upward along the flanks of the high plateau country in southern Tompkins County. The type in its lower basal portion frequently consists of a heterogeneous mass of local and glacial material dumped by the glacial ice as a massive moraine. Owing to its position at the foot of steep slopes, the torrential streams descending from the plateau region have carried down rock, gravel, and fine soil, spreading them out over the older morainal deposits. The result has been that a soil of a double origin, partly glacial and partly colluvial wash, has been formed. Even at the present day heavy storms are followed by additions of stone and soil brought down through the small gorges which cut back into the higher hills.

The Volusia stony loam lies in such a position that the seepage waters of the adjacent high hill country flow down through the subsoil of the type. This gives it natural subirrigation, forming springy and wet areas of greater or lesser extent throughout the type and particularly at or near the foot of slopes. In such cases artificial drainage is necessary and is practiced by the best farmers. In a season of drought this peculiar drainage condition is a distinct advantage, since a considerable part of the moisture which falls at higher elevations is thus made available to the crops.

The yields secured from the greater part of the Volusia stony loam are rather above the average of the county for all field crops, except possibly potatoes. Timothy yields from 1 to 2 tons; oats, from 25 to 40 bushels; buckwheat, 15 to 25 bushels, and potatoes 80 to 100 bushels per acre. Some beans and a considerable quantity of rye are grown on portions of this type.

On well-drained areas of the Volusia stony loam, particularly on northern and northwestern slopes, apple orchards are highly successful. Several new orchards have been set out in the last few years, and many farmers are recognizing that drainage and exposure play an important part in the success or failure of such attempts.

On account of its position along well-traveled roads of easy grades, because of its generally high repute for successful crop production, and also because of a general prevalence of good farm improvements, farms located on this type, which are for sale, bring good prices.

The following table gives the physical characteristics of the fine earth particles of this type, the figures being averages of determinations in the analysis of several samples:

Mechanical analyses of Volusia stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11281, 13313	Soil	3.0	4.5	2.8	6.8	13.0	47.8	22.9
11282, 13314	Subsoil	2.8	4.8	5.8	14.0	14.3	38.0	20.1

MIAMI STONY LOAM.

The surface soil of the Miami stony loam to an average depth of about 9 inches is a mealy, light-brown loam. This is underlain by a brown or mottled gray and brown loam subsoil, extending to a depth of 40 inches or more. Both soil and subsoil contain a considerable quantity of rounded stone from 1 or 2 inches to more than 1 foot in diameter. The subsoil in particular is stony or gravelly. A large part of the stone found in the type consists of limestone derived from the Tully and from other limestone outcrops to the north and brought into the region by the glacial ice.

The Miami stony loam in Tompkins County marks an extreme southern extension of the type in central New York, and possesses an undulating or sloping topography, with generally good surface drainage. Considerable areas of this soil have been mapped in the Lyons area, around Syracuse, and in Cayuga County. Throughout central New York the Miami stony loam has the reputation of being a strong, lasting, general farming soil, well adapted to grass and grain production, well suited to apple orcharding, and in general desirable.

In the Lyons area sugar beets are produced on the type, yielding 8 to 11 tons per acre. In the vicinity of Syracuse and Fayetteville alfalfa has been grown for a considerable time. The average yield per acre near Fayetteville is 2½ to 3 tons of alfalfa hay per acre. The crop is produced to advantage on Miami stony loam wherever the drainage conditions are good and the depth of soil and subsoil exceeds 3 feet. Apples are a prominent crop on this soil in Wayne County and westward in New York State.

In Tompkins County the Miami stony loam produces from 1 to 2½ tons of hay per acre, 30 to 50 bushels of corn, 30 to 40 bushels of oats, and 18 to 25 bushels of winter wheat. Farms on this soil type are valued at $35 to $50 an acre or more, depending upon the conditions of improvements and upon the state of cultivation.

The following table gives the results of mechanical analyses of the fine earth of this type:

Mechanical analyses of Miami stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11331	Soil	2.9	4.2	3.5	10.0	15.6	35.1	28.7
11332	Subsoil	2.2	4.3	3.7	11.6	16.1	36.9	25.1

A large sample of this type was collected about 1¼ miles southwest of Lansingville, in order to investigate its manurial requirements. The field from which the sample was taken has been in cultivation for about one hundred years, cropped mostly to corn, oats, and grass, with some wheat and barley. Only small to medium quantities of stable manure are used and no other fertilizers. The yields average 80 to 100 bushels of corn in the ear in seasons favorable to maturity of this crop, 50 to 60 bushels of oats, 25 to 35 bushels of wheat, 35 bushels of barley, and 2 tons of hay per acre.

The results of the experiments with this soil indicate that stable manure has a moderate effect in improving the condition of this soil, that green manure and lime give fairly good results, and that nitrate of soda, sulphate of potash, and acid phosphate and lime alone or in various combinations produce little or no increase in its productiveness. These results were anticipated from the condition and crop-yielding capacity of this soil in the field, and are in accord with the experience and practice of the best farmers on this type, with regard to general farm crops.

DUNKIRK GRAVELLY LOAM.

The surface soil of the Dunkirk gravelly loam, to a depth of about 10 inches, is a brown gravelly loam. The subsoil to a depth of 36 inches is either a gravelly loam or a coherent loamy gravel. In addition to a large quantity of gravel, both soil and subsoil in small local areas contain large quantities of cobbles and flat shale fragments. This is due to the fact that the type has been formed by stream action and where streams have flowed across portions of the type local stony patches and strips have resulted.

The Dunkirk gravelly loam in Tompkins County is found chiefly in long, narrow terraces bordering the larger stream courses. These terraces are not usually subject to overflow at the present time, and with the exception of small sloughs are usually well drained and fertile. Only small areas of the Dunkirk gravelly loam are found in Tompkins County. Nearly all of them are under cultivation, producing large crops of corn and fair crops of hay and oats. Potatoes, beans, and peas also do well on this type. Small strips of the Dunkirk gravelly loam still subject to occasional overflow are also used for pasture.

The average texture of this soil is shown by the following table:

Mechanical analyses of Dunkirk gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11275, 13311	Soil	3.8	5.6	4.0	10.8	16.8	42.5	16.3
11276, 13312	Subsoil	5.0	8.2	6.3	15.6	19.1	31.3	14.4

DUNKIRK GRAVELLY SANDY LOAM.

The Dunkirk gravelly sandy loam, to an average depth of about 1 foot, consists of a brown or yellow sandy loam containing a large percentage of rounded gravel and small stones. In fields which have been well supplied with organic manures the surface soil is distinctly brown and loamy. Elsewhere the surface soil is yellow and its sandy character is much more evident. The subsoil usually consists of a very gravelly yellow or gray sand with distinct stratification into sand and gravel layers. The whole mass is usually many feet thick, except along the margins, where it rapidly thins out.

In Tompkins County the Dunkirk gravelly sandy loam occurs as deltas deposited in former glacial lakes by rapidly flowing upland streams. In many cases a series of these flat-topped gravelly deltas extends up along the present hill slopes. This characteristic is marked at Coy Glen along Fall Creek and even in the vicinity of the smaller creeks and gorges along the Cayuga Lake slopes. A portion of the Cornell Experiment Station farm includes this soil type and many experiments have been conducted upon it. The potato experiment, in which large increases in yield were obtained by thorough cultivation and without fertilizer or manure, was conducted on this type.

In general the Dunkirk gravelly sandy loam is a light, somewhat leachy soil not well adapted to grass or wheat production, but constituting an excellent corn and potato soil. With careful cultivation, which should include the liberal use of organic manures, it is capable of producing large yields of corn, potatoes, and clover. Owing to the fact that a large part of the type lies adjacent to Cayuga Lake and because of the sandy and gravelly nature of the soil, the Dunkirk gravelly sandy loam is well suited to the production of peaches. Such areas as occur within one-half to 1 mile of Cayuga Lake are within the tempering influence exerted by that body of water upon the climate of the region. This climatic peculiarity added to the loose structure and porous texture of the soil results in conditions favorable to peaches, and the majority of the best orchards are found on the type. The area of Dunkirk gravelly sandy loam south of Taghanic Creek is almost entirely devoted to fruit, including some fine peach orchards, and should serve as a field experiment to direct the further planting of orchards along the Cayuga shores.

The yields of ordinary farm crops upon the Dunkirk gravelly sandy loam are only moderate and the type should be used as a fruit, potato, and corn soil.

The following table gives the texture of the type, the figures representing the averages of several determinations:

Mechanical analyses of Dunkirk gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
10764, 13291	Soil	12.4	13.0	5.1	16.5	13.9	24.7	14.8
10765, 13292	Subsoil	12.5	17.2	6.4	24.4	13.1	13.8	12.3

DUNKIRK STONY CLAY.

The surface soil of the Dunkirk stony clay, to a depth of about 8 inches, consists of a yellow or brown heavy loam or clay loam. The subsoil, from 8 to 36 inches or more in depth, consists of a chocolate colored or mottled brown and gray clay. Both surface soil and subsoil contain varying proportions of rounded and angular stones. Frequently a large part of any single field is only slightly stony, while small areas and long narrow bands will contain enough stone seriously to interfere with cultivation. On the best managed farms the stones have frequently been gathered into piles or built into road or boundary fences. The entire mass of soil and subsoil usually rests on shale or sandstone rock at a depth varying from 18 inches to 5 or 6 feet.

The Dunkirk stony clay occupies sloping to steep areas along both sides of Cayuga Lake and along the margins of the tributary valleys to an average elevation of about 600 feet above lake level. It is also found in several of the smaller glacial lake areas near Dryden and in the upland valleys. The type represents the fine clayey sediments deposited in the bygone lakes, together with glacial bowlders and local sandstone and shale also carried into these areas by various means. Along the Cayuga Lake shore a considerable part of the type has been formed by the erosion of what were formerly areas of Dunkirk clay loam. The fine earth of the original type has been carried away and redeposited elsewhere, while the stones, which were previously scattered through a considerable depth of soil and subsoil, have been left behind to accumulate upon the surface of the type as it now exists. This rapid erosion still continues and constitutes one of the most serious problems in the management of the Dunkirk stony clay. Lying as it does on steep slopes, every heavy storm sends small temporary streams across its surface, frequently washing gullies across the tilled fields. The surface of the type also bakes and compacts and a large proportion of the rain which actually falls upon it rapidly flows off, carrying way in suspension much surface soil. No large amount of erosion occurs at any one time, but the removal under ordinary methods of tillage is on the whole so rapid that the farmer is usually under the necessity of farming the subsoil instead of the soil over some parts of his fields.

The Dunkirk stony clay is farmed to wheat, corn, and grass, producing low yields in the majority of cases. In the vicinity of South Lansing there are several very well-tilled farms upon this type which are producing good yields. Elsewhere in Tompkins County the yields are less. In general about 1 ton of hay, 20 to 30 bushels of corn, and 12 to 18 bushels of wheat per acre constitute good average yields.

The Dunkirk stony clay is well suited to the production of wheat, oats, and hay, where the surface slope is not too great or where careful farming prevents too rapid surface erosion. By the use of lime and stable manure yields of 2 tons of clover and 25 bushels of wheat have been produced upon this type in recent years. This soil should be kept in grass as much as possible in order to hold the surface soil in place. Upon steep slopes the plowing and cultivation should be done by the contour system, as employed in the southern States. By this method the rows and furrows are carried nearly horizontally around slopes. When, in addition, uncultivated bands of sod are left also running horizontally along the slope the continual loss of surface soil can largely be prevented.

Among fruits, apples and pears are well suited to the Dunkirk stony clay. Within a distance of one-half mile to 1 mile from Cayuga Lake grapes are also grown to advantage. In setting out vineyards the rows should run horizontally and not up and down hill. One vineyard of the latter class was seen where the upper ends of the intervals between vine rows consisted of deep gullies and the lower ends were piles of mingled stones and earth. This ruinous erosion could have been prevented by running the rows horizontally.

The following table gives the average results of mechanical analyses of typical samples of this soil:

Mechanical analyses of Dunkirk stony clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11403, 12282	Soil	0.8	1.7	2.3	11.2	13.6	43.9	28.1
11404, 12283	Subsoil	1.1	1.6	1.9	9.2	12.4	35.9	37.7

DUNKIRK CLAY LOAM.

To a depth of about 8 inches the surface soil of the Dunkirk clay loam consists of a brown or yellow heavy loam. The subsoil to a depth of over 36 inches consists of a chocolate-brown silty clay or of the same material mottled brown, yellow, and gray.

This soil when wet is sticky and plastic. Upon drying the surface cracks into irregular masses and polygonal blocks. Frequently when the surface of a cultivated field is stirred when wet the soil settles into an almost cementlike mass.

Over the greater part of the type the surface is level to gently undulating. Drainage is fair to poor and needs to be supplemented by tiling on a majority of the farms.

The Dunkirk clay loam consists of glacial material reworked by streams and redeposited in glacial lakes and ponds as a quiet water sediment. The subsoil is frequently stratified or laminated. Only occasional stones or bowlders occur on the surface of the type, but near its margins some stones have become mingled with the soil. When only a thin sheet of the type occurs covering glacial deposits the stones from the latter sometimes work up into the soil.

The Dunkirk clay loam is an exceedingly heavy silty clay loam marked by massive structure, by plasticity when wet, and by a considerable degree of compactness when dry. It is a type of soil adapted to the production of oats, wheat, timothy, and bluegrass. It is not a favorable soil for potatoes or corn, and the yields of these crops on this type in Tompkins County are not usually satisfactory. Over the type in general the hay yield is 1 to 1½ tons per acre; that of corn 25 to 30 bushels. Oats produce 40 bushels or more, wheat about 20 bushels, and potatoes 80 to 100 bushels per acre.

A considerable proportion of the Cornell Experiment Station farm is occupied by the Dunkirk clay loam, which has here been brought to a high state of cultivation. Hay has yielded 4 to 4½ tons, wheat 35 to 42 bushels, and oats frequently 60 to 80 bushels per acre. These results were secured by good drainage, careful tillage, and the liberal application of stable manure in connection with small amounts of mineral fertilizers. A four-year rotation of corn, oats, wheat, timothy, and clover is practiced. Clover freezes out badly on the type and can only be grown where the drainage conditions are the best.

In the production of corn upon this type the experiment station has found that the grain can not always be matured, and it is better to produce corn for silage purposes. From 15 to 20 tons of excellent silage per acre have been produced. Mangels also yield heavily, giving as high as 45 tons per acre.

While such results probably can not be secured under the ordinary necessities of farm practice, at the same time they serve to indicate the wonderful possibilities of this soil for crop production under intensive systems of culture.

The Dunkirk clay loam is a very good grass and small-grain soil. It should produce crops for cattle and dairy feeding, and would benefit from such a system of agriculture, because it needs organic fertilizers.

The following table gives the average results of mechanical analyses of typical samples of this type:

Mechanical analyses of Dunkirk clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
10760, 10762, 13299, 13301.	Soil	0.5	1.1	0.8	3.4	7.3	56.8	29.9
10761, 10763, 13300, 13302.	Subsoil	.4	.7	.5	1.5	4.7	56.9	35.0

In order to obtain an idea of the manurial requirements of this type a large sample was collected about 2 miles east of Ithaca. The soil consists of a brown heavy silt loam and was sampled to the average depth of cultivation, about 6 inches. The underlying subsoil is a clay loam, and the soil is retentive of moisture to a degree that makes it cold and late. The field from which the sample was taken has been in cultivation for more than fifty years. Grass, oats, and corn are the chief crops and are grown in a somewhat regular rotation. Moderate applications of stable manure have been used, and no other fertilizer. The yields on this farm average 2½ tons of fine quality hay per acre, 50 to 70 bushels of oats, and 50 to 60 bushels of corn in the ear in favorable seasons.

The sample from this farm was subjected to tests in wire baskets, and the results obtained indicate that, using wheat as an indicator, stable manure has a highly beneficial effect on the soil; that nitrate of soda and sulphate of potash separately improve the soil slightly, while in combination in equal proportions they produced a fair increase in productivity.. Acid phosphate and lime alone or in combination with other elements of fertility have little or no beneficial effect. These results were obtained under favorable climatic conditions for the crop and by having the soil in the best possible condition both physically and as regards to moisture content. Lime might prove of decided benefit in the field from its physical effect on soil texture and structure, but this action has been largely eliminated under the conditions of the test.

These results are held to be applicable only to the field from which the sample was taken, but they are in agreement with the general practice on this type in the area and with the experience of the farmers.

DUNKIRK LOAM.

The Dunkirk loam possesses a mealy brown or yellow loam surface soil, which reaches to an average depth of about 10 inches. This surface soil contains highly variable proportions of very fine sand. In general the surface soil is sufficiently sandy to be distinctly friable. At the same time enough silt and clay are present to cause it to pack and even to form clods when tilled in a wet condition. From 10 to 24 inches in depth there is frequently present a layer of light-gray or yellow loamy fine sand. This may be lacking, however, over a considerable proportion of the type. In general the surface loamy material grades imperceptibly into a sandy clay or a clay loam at a depth of 24 to 36 inches. Where the surface soil has been subject to erosion, as on steep slopes, the underlying clay often appears nearer the surface.

A moderate amount of flat shale and sandstone fragments occurs in both soil and subsoil. The quantity of stone present increases near the boundaries of the type and on steep slopes.

The Dunkirk loam constitutes a marginal deposit of old glacial material reworked and redeposited in Glacial and post-Glacial lakes. It is most widely developed along the shores of Cayuga Lake, along the east side of Salmon Creek, and in the vicinity of Dryden Lake. Its surface is sloping to steep, although certain areas around Dryden Lake are more nearly level.

The soil type is extensively planted to pear, peach, cherry, and plum orchards in Ithaca Township along the slopes on the west side of Cayuga Lake. It is also used for fruit culture in Seneca and Cayuga counties, and many successful orchards are located upon it. Where the surface slopes are not too steep, it also constitutes a good general farming type. It is better suited to corn and potatoes than the heavier Dunkirk clay loam, and, on the other hand, its yields of grass and small grain exceed those of the Dunkirk gravelly sandy loam.

Frequently the more level or depressed areas of the Dunkirk loam would be benefited by underdrainage. Some stone and some tile drains, have been laid under this type, and they have always given satisfactory results when properly laid.

The use of stable manure and of green manures upon the Dunkirk loam is attended by better results than the use of chemical fertilizers, according to the testimony of several progressive farmers located on this type. Crop yields amounting to 20 bushels of wheat, 35 bushels of corn, 1 to 1½ tons of hay, and 40 bushels of oats are obtained in average seasons. Some buckwheat is annually sown, and potatoes constitute one of the minor crops produced on this soil.

The following table gives the average results of mechanical analyses of both soil and subsoil of this type:

Mechanical analyses of Dunkirk loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11279, 11354, 12286.	Soil	1.5	2.8	2.2	12.4	20.0	43.1	18.0
11280, 11355, 12287.	Subsoil	1.3	2.7	1.8	9.5	21.0	43.3	20.0

Wire-basket tests were made of a large sample of this type of soil, collected about 2 miles west of Ithaca. The soil here consists of 8 to 10 inches of brown silty loam containing some rock fragments. The sample was taken to the average depth of cultivation—about 6 inches. The field is well drained, warm, and early, and has been in cultivation for seventy or eighty years. Corn, oats, hay, wheat, buckwheat, and truck are the important crops. The yield averages, in favorable seasons, from 40 to 60 bushels of corn, 40 to 60 bushels of oats, 15 to 20 bushels of wheat, 20 to 25 bushels of buckwheat, and 1½ to 2½ tons of hay per acre. Some stable manure is used, but no other fertilizers.

The results of the examination of this sample indicate that stable manure has a marked effect on the productiveness of the soil; that nitrate of soda is fairly beneficial, and that sulphate of potash, acid phosphate, and lime alone or in various combinations are of little or no benefit. These results were obtained under climatic conditions favorable to the crop and with the soil in the best possible physical condition and moisture content. They are held to be strictly applicable only to the field from which the sample was taken, but they are in agreement with the general practice and best experience of farmers on this type of soil.

DUNKIRK FINE SANDY LOAM.

The Dunkirk fine sandy loam possesses a brown or yellow fine sandy loam surface soil, with an average depth of about 6 inches. The subsoil to a depth of 3 feet or more is a gray or yellow medium to fine sand. Both soil and subsoil contain varying quantities of fine gravel. The type is well drained and warm, and matures crops having a short growing season to better advantage than the heavier soils.

The Dunkirk fine sandy loam occupies nearly level flat-topped areas, which are usually minor stream deltas closely related in point of origin to the Dunkirk gravelly sandy loam. The largest area of this type is found in the vicinity of Taghanic Creek, south of Trumansburg. It is largely used for the production of small fruits, truck crops, and beans, and furnishes a good example of a case where the special adaptation of a soil to particular crops has been utilized in Tompkins County. Recently cucumbers for pickling purposes have also been grown on the type. This crop has been introduced so recently that little could be learned concerning the soils best suited to its production. With some limitations, however, good results were secured on the Dunkirk fine sandy loam.

Both organic manures and commercial fertilizers are used extensively on this type, and those engaged in the production of the small fruit and truck crops were of the opinion that both kinds of fertilizers used together produced better results than either used alone.

The following table gives the results of mechanical analyses of typical samples of this type:

Mechanical analyses of Dunkirk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13297	Soil	1.3	4.3	4.3	23.8	32.5	24.1	9.3
13298	Subsoil	1.1	3.3	5.3	27.5	32.8	23.5	6.4

DUNKIRK SILT LOAM.

The surface soil of the Dunkirk silt loam to an average depth of about 9 inches is a yellow or brown friable silty loam. This is immediately underlain by a lighter colored silt or very fine sand, which usually grades down into a brown silty clay at about 30 inches in depth.

The type occupies knolls and irregular valley slopes in the West Danby Valley and consists of stratified or laminated lake deposits, which have been badly eroded. It is closely related to the Dunkirk loam, but differs in possessing more very fine sand and silt in the surface soil and in the upper portion of the subsoil.

Aside from its rather rough surface topography the type constitutes a good soil for general farming purposes, producing good crops of corn, 1 to 2 tons of hay, 20 to 28 bushels of wheat, and 40 to 60 bushels of oats per acre. The apple orchards on this type are productive, and the soil is well suited to apple culture. In former years peaches were cultivated to a considerable extent upon the Dunkirk silt loam. Orchards situated upon the slopes where drainage was good and the exposure favorable were thrifty and produced good crops of excellent quality. The business of peach production is not so extensively followed as formerly, but the opportunities on this type are good. Pears, plums, and cherries also do well.

The following table gives the average results of mechanical analyses of the Dunkirk silt loam:

Mechanical analyses of Dunkirk silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13303, 13305	Soil	0.4	0.9	0.9	4.3	8.1	71.4	13.6
13304, 13306	Subsoil	.1	.6	.5	2.2	6.6	69.7	19.6

DUNKIRK SHALE LOAM.

The entire mass of the Dunkirk shale loam from the surface to a depth of 36 inches or more consists of flat, angular fragments of shale and sandstone several inches to 1 foot or more in breadth, mingled with a fine-grained brown loam containing considerable quantities of partially decayed organic matter. In some cases the loam changes to a gray or yellow color at a depth of about 18 inches.

The Dunkirk shale loam consists of low, flat, cone-shaped masses of stony material washed down by intermittent streams and piled up where the stream emerges upon more level land and on steep slopes along stream gorges. The larger areas are less noticeably conical, but all are sloping to steep. New material is added to many portions of this type with every flood and except for the difficulty experienced in tilling such a stony soil, the Dunkirk shale loam would constitute valuable land for grass and grain production. Corn produces good yields and oats, timothy, and clover do well. Many of the smaller areas are left in pasture, not only because of the rough, stony surface, but largely because unseasonable floods may completely destroy any cultivated crop.

The following table gives the results of mechanical analyses of this soil:

Mechanical analyses of Dunkirk shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13307	Soil	2.2	5.8	1.2	1.2	3.2	53.7	32.6
13308	Subsoil	.9	6.7	18.6	43.7	9.7	12.7	7.6

WABASH LOAM.

The Wabash loam, to an average depth of 24 inches, consists of a brown mealy loam well filled with partially decayed organic matter and free from stone or gravel. The subsoil is usually a gray or drab loam, although small patches of blue clay subsoil occur in some localities. At a depth of 36 inches to 4 feet sand or gravel usually is found.

The Wabash loam consists of fine earth washed down by stream action from higher lying types and thoroughly mingled with considerable quantities of partially decayed organic matter. It occupies stream bottoms subject to overflow and also a large proportion of the Cayuga Inlet Valley, which was once a portion of the lake. The surface of the Wabash loam is nearly flat or gently inclined, and drainage is frequently poor. As a consequence the greater part of the type in Tompkins County is used for pasture or for meadow. Better drained areas, particularly near Ithaca, are also used to a small extent for the production of celery, cabbages, onions, and other truck crops.

The Wabash loam is badly in need of drainage. When well drained it produces excellent crops of corn and oats and is one of the best timothy soils in the area. In the Cayuga Inlet Valley the type should be protected as much as possible from overflow, and also drained by open ditches in order to furnish a rich productive location for market gardening. The fertility of the type is practically inexhaustible, and the Inlet Valley is situated favorably for extensive farming operations.

The following table shows the physical composition of the type:

Mechanical analyses of Wabash loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13809	Soil	0.3	1.4	0.9	6.9	18.4	51.0	21.1
13810	Subsoil	11.3	13.9	2.4	1.9	3.0	45.4	21.8

ROUGH STONY LAND.

Throughout the southern portion of Tompkins County and also along the shores of Cayuga Lake there are many areas, included within different soil types, the surface of which is so steeply inclined that they can not readily be brought under cultivation. The soil is usually not markedly different from that of the adjoining or surrounding types, although there is often an excess of shale and sandstone fragments. Such areas have been mapped as Rough stony land.

These areas in Tompkins County are chiefly forested or to a less degree used for hill pasture. They should all remain forested, and in that condition would be of far greater value than if cleared and pastured. Although the surface of the county was originally covered by forests, practically all of this timber has been removed, and the supply still remaining in the county is very meager. There is an increasing necessity for reforesting at least the rougher, noncultivable land, in order that fuel, fence material, and lumber may again be produced for local use.

MEADOW.

Level or depressed areas of poorly drained land, some of which are subject to frequent overflow, have been classed as Meadow. This classification is based on the swampy condition of the material and not upon its texture or composition, which may vary greatly. The Meadow areas usually possess a dark mucky surface soil to a depth of several inches or even a foot or more. The meadows in the Cayuga Inlet Valley are particularly marked by this mucky soil, and in many instances a little artificial drainage would reclaim these lands. They would then constitute valuable soils for the production of such truck crops as onions, cabbages, and celery. Many of the upland Meadow areas are forested to water maple, birch, ash, and other water-loving trees. Other areas are cleared and included in pasture.

The majority of these areas owe their present condition to small local obstructions to the natural drainage, and a few open ditches, dug for short distances, would reclaim considerable areas of unsightly and unprofitable bogs. With land at its present price in Tompkins County no great expenditure of money would be justifiable for such drainage, but in a large number of cases a few days' work with teams, plows, and scrapers would greatly improve the drainage conditions.

These Meadow areas, when properly drained, are almost uniformly of high productiveness, and when once subdued they maintain their ability to produce crops for a considerable length of time.

AGRICULTURAL CONDITIONS.

In the early days of the agricultural development of Tompkins County the clearing away of the forests constituted the first duty of the settlers, and also for the first few years brought them their largest income. A few Indian fields existed in the vicinity of Cayuga Lake, and upon these the settlers grew their first crops. As the country became more thickly populated and the timber lands were cleared wheat became the important crop. The completion of the Erie Canal in 1825 and its connection with Cayuga Lake by means of a feeder afforded excellent facilities for the water transportation of this grain to the seaboard markets. As a result, all of that part of Tompkins County contiguous to Cayuga Lake became a wheat-producing section, and elevators were built at Ithaca and at various points along the shores of the lake. Many of these old structures have fallen into decay, but a few remain and are used for other purposes. When the Western States were settled and new wheat lands were developed, Tompkins County experienced a decline in the profitability of wheat culture, in common with other sections of the Eastern States producing this crop. As a result, large areas of land were devoted to the production of oats, hay, and corn. The tendency toward grain production in Tompkins County has, however, survived until the present time, the production of grain and of hay still dominating the agricultural practice of the area. In 1899 hay occupied 66,725 acres of the cultivated land in the county. Nearly 24,000 acres were devoted to oats, over 16,000 acres to buckwheat, 13,000 acres to wheat, about 11,000 acres to corn, nearly 5,500 acres to potatoes, and less than 1,600 acres each to rye and barley. With the exception of the northeastern part of the county, a great part of the hay crop cut in Tompkins County is baled and sold. The meadows remain in sod for three or four years, and are then plowed and planted to corn or, in case of an unfavorable season, to buckwheat. These crops are followed either by oats or wheat, and after either of these crops the ground is again sown to grass. The rotations vary in different parts of the county, but follow this general outline.

The census of 1900 reports 81 per cent of Tompkins County as improved land. The average size of the farms is given as 71 acres, the average value per acre is $20.90, and the average value per acre of the buildings is $15.30, thus giving an average value of the farms with their improvements of $36.20 per acre. The average figures of course mean little for particular farms. Farm values in Tompkins County range from $6 or $7 an acre in the more inaccessible, hilly regions to $100 and $125 an acre in the vicinity of Ithaca. The greater number of farms in the county can be purchased at prices ranging from $30 to $50 an acre, and upon these farms the improvements may be described as fair.

The average yield per acre of the principal crops produced in the county are a trifle below the average for the State. The census of 1900 gives the following: Hay, 1 ton; oats, 31½ bushels; buckwheat, 12 bushels; wheat, 20 bushels; corn, 26 bushels; barley, 24 bushels; rye, 13 bushels, and potatoes, 103 bushels per acre. These yields are somewhat higher than those reported by the census of 1890. It will be seen, therefore, that the farms of this county are still producing from 18 to 20 bushels of wheat and about 1 ton of hay to the acre each year. The buckwheat crop is much more variable in its yields, and the corn crop depends almost entirely upon the weather conditions for the amount of grain returned per acre. At the time of making the soil survey of Tompkins County there had been two seasons unfavorable for corn, and it was a common sight to see fields that had been planted to corn harrowed over and replanted to buckwheat. In some instances corn of two different plantings and a crop of buckwheat could be seen growing in the same field. This practice of displacing an unpromising or backward growth of corn is common throughout central New York.

The northeastern part of Tompkins County is more generally devoted to dairying than any other part of the area. This may be due to two reasons. For one thing, it adjoins Cortland County, where dairying has been an important industry for a number of years and the practice has spread across the border into the northeastern townships of Tompkins County. Another reason is found in the excellent transportation facilities afforded by the railroads crossing this part of the county. There are several skimming and pasteurizing stations located at convenient points along the railroads. The milk is hauled from the farms to these stations, where frequently it is bottled before being shipped to the city. Most of it goes to New York City and Philadelphia. In times of surplus milk production, and in some cases throughout the year, the milk is skimmed and only the cream is shipped, or else made into butter. This section of the county presents a much more prosperous appearance than the remainder of the county. The buildings are in better condition and many of the farms are improved with comfortable houses, excellent basement barns, and silos.

Tompkins County, in common with a large proportion of New York State, is seriously troubled with the labor problem. There is a general complaint of the scarcity of help and the general impression is that a majority of the young men of the rural communities are leaving the farm and securing employment in the manufacturing towns. The wages paid farm laborers vary considerably in different parts of the county and also with the season. Day labor generally receives from $1.25 to $1.50. Laborers employed by the month receive from $18 to $22 a month with board, or $25 to $32 a month without board. The greatest scarcity of labor occurs during the months of July, August, and September; that is, during the hay and harvesting season. Under the prevailing system of grass and grain farming this scarcity of labor can not readily be overcome. Not only does the greatest demand for labor occur within this short season, but it occurs simultaneously all over that portion of New York State. The best farm laborers are not content to work, even at high wages, for three months in the summer and take their chances on securing occasional employment during the rest of the year. As a result, the more ambitious men rent farms, or secure employment in other agricultural regions where work is more continuous, or go to the manufacturing towns and secure regular work at regular wages. There seems to be but one remedy for this condition, and that is for the farms to be so managed that good labor can find employment during the entire year. This is not possible under the present system of grass and grain farming, but it is not only possible but absolutely essential under a well-organized system of dairying and stock raising. In fact, in the dairying region of Tompkins County there is less discouragement over the labor situation than in the grass and grain farming districts.

The present development of agriculture in the county is far from satisfactory. Throughout the southern townships, though not confined to them, land is for sale at prices which would little more than pay for the improvements. During the progress of the survey over 150 vacant houses were counted in various parts of the area. These constitute the so-called abandoned farms of the northeastern States. Inquiry developed the fact that while the buildings were unoccupied the land was, in all cases, used for some agricultural purpose and was held either by some farmer nearby or by some one living in a town or city. The abandonment is one of houses rather than of land. Nevertheless, the situation is such as to promote a low grade extensive farming, instead of a high grade intensive cultivation of the land, and there seems to be a tendency for the smaller farms in the hilly districts to coalesce into large holdings. The average size of the farms for the county is not materially increased, however, since at the same time some of the larger farms in the vicinity of the towns are being broken up into smaller holdings which are used for the fruit, market gardening, and poultry industries. The average statistics for the county are, to this extent at least, somewhat misleading.

The low-priced farms of Tompkins County furnish an excellent opportunity for the young, progressive men, possessed of a small capital and capable of increasing the productivity and the value of these farms by the use of proper agricultural methods. These lands are still capable of producing about 1 ton of hay per acre, and fair crops of oats and buckwheat. Many of them are partially improved with fair buildings and neglected orchards. A change from grass and grain farming, which is becoming unprofitable, to dairying and stock raising is imperative.

A section of the county adjoining Ithaca and following both sides of Cayuga Lake is quite extensively devoted to fruit growing, the fruit belt being confined by climatic conditions to the vicinity of the lake. Here peaches, plums, pears, cherries, and apples are grown to good advantage. A few small vineyards also occur. Small fruits, such as raspberries and strawberries, are cultivated in small patches. The berries and garden products are sold only in the local markets. As a result, during some seasons of the year there is a glut and prices are extremely low, while at other seasons the vegetables and fruits sold in the local markets are imported from other regions. There has been little attempt to ship to distant points any other fruit than apples, except in the case of a few successful peach growers. There are several peach orchards north of Ithaca Township from which shipments are made, and while the industry is only partially developed, those who are engaged in it have met with a fair degree of success. It was noticed during the progress of the survey that the finest peach orchards were located either upon the Dunkirk gravelly sandy loam or upon the Dunkirk loam. A few orchards planted upon the Dunkirk clay loam have produced only one or two successful crops in from five to ten years. Near Shurgers Point, to the northward along the east shore of Cayuga Lake, there are several vineyards. The largest of these comprises only 10 or 12 acres. Where these vineyards are properly cared for, good yields of grapes of excellent quality have been secured. In some instances, however, the vines have been planted with the rows running up and down hill, and erosion on the steep slopes has been so great that the vineyards are partially destroyed. The grape industry should prove profitable on the Dunkirk clay loam and the Dunkirk loam, in a belt about one-half mile wide on each side of Cayuga Lake.

It can scarcely be said that the county is a prominent fruit-producing region. Nearly every farm throughout the county has a few apple trees in the vicinity of the farm buidings. Only a few commercial orchards have been planted, however, and in the majority of cases instead of being confined to one or two varieties of shipping quality they have been planted to half a dozen kinds, so that no considerable output of any standard-grade apple can be secured from a single orchard. The buyers who make their headquarters in the counties south of Lake Ontario occasionally visit Tompkins County and secure some apples, but in the majority of cases the apples are shipped in quantities of a few barrels to the city commission merchants.

The conditions observed in Tompkins County indicate the necessity for a slow but decided change in the character of the agriculture of the area. The production of grass and grain can no longer be carried on at a profit. Only farmers of more than average ability, both in the technicalities of their occupation and of business management, are securing much more than a fair living. Without some form of animal husbandry the annual expenditure for commercial fertilizers makes considerable inroads upon the cash returns from the farms. Green manuring is practically unknown in the area, the use of lime was discontinued many years ago, and the farmers secure either a minimum of stable manure or small quantities of commercial fertilizers as their only assistance in producing crops.

One of the great problems confronting the farmers of Tompkins County is the prevention of rapid soil erosion along the steeper slopes. This is particularly true in the vicinity of Cayuga Lake, where the clays and heavy loams occupy slopes of 300 and 400 feet to the mile. The compactness of the soil tends to throw a large proportion of the rainfall into surface drainage, with consequent ruinous effects accompanying every heavy storm. It is extremely difficult or impossible to maintain a proper surface soil over the subsoils under these conditions. Little or nothing is known of contour cultivation, although its introduction would improve the farm conditions on the steeper slopes.

There are several farmers in this general region who have, by the careful use of stable manure and the aid of an occasional green crop plowed under, maintained the producing power of their land at a point far above the average attained by their neighbors. These men furnish samples of what can be done by the use of proper methods of soil management. With the addition of lime still greater increases in crops could be secured. Upon the heavy clays and loams from 1,500 to 2,000 pounds of lime per acre should be used once during the four or five year rotation. With the use of lime clover seeding is practicable, but without it the seeding of clover is not infrequently so much seed and labor thrown away.

The local markets of Tompkins County are Ithaca, Dryden, Groton, and Trumansburg. At the latter place there is a bean-cleaning establishment, and also a recently established pickling plant, both of which furnish an outlet for agricultural products. The production of cucumbers for pickling is a new industry in Tompkins County, and its success or failure can not be predicted at the present time.

The transportation facilities are good. Two main lines of railroad enter the county, and nearly every part of the area is within 5 or 10 miles of a railroad station. Aside from the difficulty experienced in hauling heavy loads over the hilly roads the highway system is very good. The money system of highway improvement is followed in most of the townships, and the results have been much better than those obtained under the old system of working out the highway tax.

SOIL SURVEY OF THE BINGHAMTON AREA, NEW YORK.

By ELMER O. FIPPIN and WILLIAM T. CARTER, Jr.

LOCATION AND BOUNDARIES OF THE AREA.

The Binghamton area occupies the central part of Broome County, which is located in the south-central part of New York, adjacent to the Pennsylvania State line. The area is rectangular in outline and has a width from east to west of 13 miles and a length north to south of nearly 17½ miles. It contains 146,560 acres, or about 229 square miles. It lies between 75° 45′ and 76° west longitude and 42° and 42° 15′ north latitude.

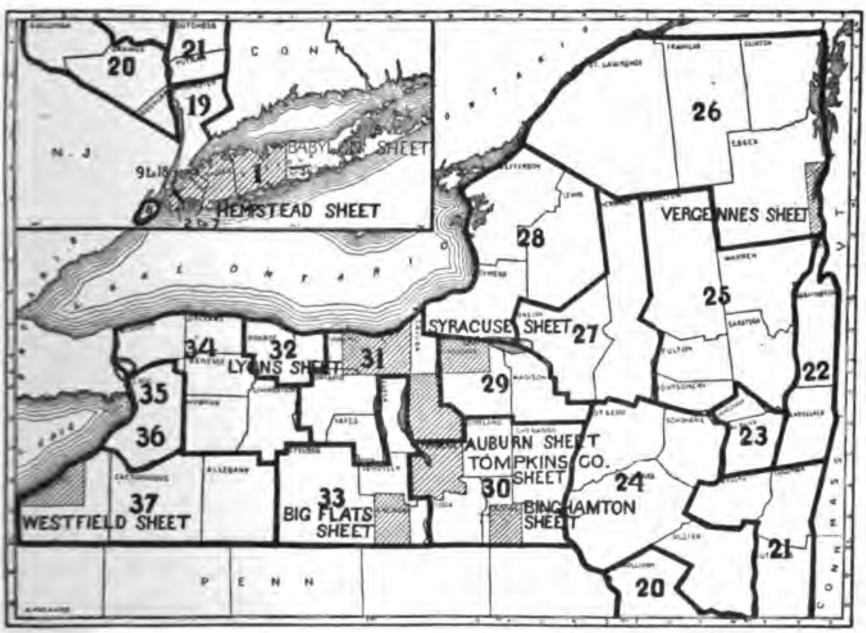

FIG. 2.—Sketch map showing location of the Binghamton area, New York.

Binghamton, the county seat, has a population of about 45,000, and is situated near the center of the area, at the junction of the Chenango and the Susquehanna rivers. It is on a direct line between New York City, distant 145 miles in an air line, or 207 miles by rail, and Buffalo, about the same distance west.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The first settlement in the area was made at Chenango, now Binghamton, in 1787, by Capt. Joseph Leonard. Broome County was organized on March 28, 1806, and in 1810 had a population of 6,524. The land came into the possession of the settlers through patents granted to various companies and persons by the General Government, following the custom of the English Government. The land surveyed was embodied in some five or six such "patents" or grants. The policy of the grantees was to promote the sale and settlement of their land. Through the agency of a Boston company many settlers came from Massachusetts, and William Bingham, of Philadelphia, who held a grant of a strip of land 1 mile wide on each side of the Susquehanna River, sent settlers to that region. The population of the county was thus mostly of English extraction and drawn from the earlier colonial settlements of Vermont, Massachusetts, Connecticut, New Jersey, Pennsylvania, and the eastern counties of New York. Among them were many soldiers of the Revolutionary war.

The chief activity of the early settlers was lumbering, and the products of the extensive forests, chiefly pine, which occupied the valleys and the uplands, were rafted down the Susquehanna River and found a market on the coast. In those early days the profit in lumber was such that agriculture held a secondary place and continued to do so until the timber was well exhausted.

Settlement was active until about the year 1825, when the Erie Canal was opened for use, and this outlet to the west led the stream of emigration to the more remote regions conveniently reached by the use of that thoroughfare. The Chenango Canal, extending from the Erie Canal at Utica to Binghamton, was opened for use in 1837 and promoted settlement in this county. It was about this time that agriculture began to be actively followed and lumbering declined in importance. The development during the next forty years was rapid and regular and was aided by the extension to Binghamton of the Erie Railroad in 1849, and of others a few years later. Cereals, hay, and potatoes were the leading crops, and later tobacco became important. In 1890, 84,100 pounds of tobacco were produced in the county, mostly in the large river valleys. After 1890 the production of tobacco declined rapidly, and during the progress of the survey only one small field was encountered. Since 1880 there has been a decrease in the area of other cultivated crops, particularly on lands outside of the main valleys, with a corresponding increase in the area of pasture. This is shown by a comparison of the following statistics, covering decennial years since 1860, as reported by the United States Census.

Acreage and production of the leading crops and the number of cattle kept in Broome County, N. Y., 1860 to 1900, inclusive.

Year.	Corn.		Wheat.		Oats.		Hay.	
	Acres.	Bushels.	Acres.	Bushels.	Acres.	Bushels.	Acres.	Tons.
1860	....	149,329	....	67,498	....	540,233	....	58,072
1870	....	202,095	....	63,203	....	623,661	....	101,955
1880	9,673	281,955	6,116	77,335	22,485	728,242	92,963	100,534
1890	3,928	109,543	1,326	19,579	21,941	604,938	106,628	119,057
1900	4,895	125,860	962	15,980	20,341	559,420	97,323	91,101

Year.	Buckwheat.		Potatoes.		Tobacco.		Live stock.	
							Milch cows.	Other cattle.
	Acres.	Bushels.	Acres.	Bushels.	Acres.	Pounds.	Number.	Number.
1860	....	116,915	....	192,813	....	11,000	14,313	9,230
1870	....	136,085	....	450,028	....	25,642	24,649	13,001
1880	8,804	126,910	5,086	469,316	53	67,510	29,398	16,632
1890	7,259	116,279	6,204	298,418	77	84,100	28,411	10,128
1900	6,102	76,530	7,248	658,892	3	3,000	34,320	21,183

These figures show several changes in the agricultural conditions of the county. There has been a remarkable decrease in the production of grain crops since 1880. While there is a decrease in grain production, there has been an increase of 20 per cent in the number of cattle kept and an increase in dairy products. At the same time the manufacture of dairy products has been transferred from the farm to the central factory.

The decrease in the yield of crops must be attributed to the lack of proper methods of soil management. In considering these conclusions as far as yield per acre is concerned, the fact that the differences may be partly due to difference in the seasons must be kept in mind.

A beet-sugar factory was formerly located on the railroad 3 miles east of Binghamton, and was operated from 1898 until 1903, when it was discontinued and the machinery sold. It had a capacity of 500 tons of beets per day. It was unsuccessful, because the farmers adjacent to the factory could not be induced to grow enough beets to give the factory a full season's run. Beets were shipped in for a distance of 100 miles, but the freight rates prevented this practice from being profitable. It was shown that beets of good quality and giving a fair yield could be produced on the Wabash loam, Dunkirk silt loam, and, with a less degree of success, on the coarser textured soils of the region.

CLIMATE.

The salient characteristics of the climate are shown by the following table of temperature and precipitation, taken from the records of the U. S. Weather Bureau stations at Binghamton and Oxford. The latter town is near the center of Chenango County, in the valley of the Chenango River, some 20 or 30 miles northeast of the area surveyed:

Normal monthly and annual temperature and precipitation.

Month.	Binghamton.		Oxford.		Month.	Binghamton.		Oxford.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*In.*	*°F.*	*In.*		*°F.*	*In.*	*°F.*	*In.*
January	23.4	2.23	22.5	2.83	August	67.6	3.88	65.7	4.17
February	23.5	2.72	22.9	2.59	September	61.5	3.00	58.7	3.55
March	32.8	3.13	31.3	2.83	October	49.7	3.03	46.9	3.44
April	45.5	1.97	43.9	2.93	November	38.2	2.31	35.9	2.84
May	56.8	3.16	55.5	3.95	December	27.6	2.72	27.8	2.74
June	65.9	3.48	64.2	4.24					
July	69.8	3.12	68.3	4.28	Year	46.9	34.75	45.3	40.39

The temperature as shown by these records is 1.6 higher and the rainfall is 5.64 inches less at Binghamton than at Oxford. The former city has an elevation of 850 feet, which is about 150 feet less than that at Oxford. Since both records have been taken in rather deep river valleys it is probable that they show somewhat warmer average temperatures and somewhat less precipitation than prevail on the rolling country outside of the valley, where the elevation is 1,000 feet greater.

The mean annual temperature is 46° F. and the precipitation is about 36 inches. About half of this falls in the five growing months from May to September, inclusive, and the distribution in these months is, as a rule, very uniform. In winter the weather conditions are fairly constant, with a considerable fall of snow.

The average length of the growing season at Binghamton is one hundred and fifty-three days. The latest and earliest killing frosts are May 2 and October 2, respectively. The dates of the first and last killing frosts at Binghamton and Oxford for the years 1897 to 1904, inclusive, are given in the following table. It will be seen that the length of the growing season at Oxford is on the average seventeen days shorter than at Binghamton.

Dates of first and last killing frosts.

Year.	Binghamton.		Oxford.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1897	May 22	Sept. 28		Sept. 28
1898	Apr. 13	Oct. 17	May 9	Oct. 17
1899	Apr. 17	Sept. 16	May 16	Sept. 15
1900	May 11	Sept. 19	May 11	Sept. 19
1901			May 14	Sept. 20
1902	May 15	Oct. 10	May 21	Sept. 6
1903	May 2	Oct. 22	May 6	Sept. 30
1904	Apr. 22	Sept. 23	Apr. 23	Sept. 22
Average	May 2	Oct. 2	May 10	Sept. 23

PHYSIOGRAPHY AND GEOLOGY.

The topography of the Binghamton area is that of a very much eroded plateau region, into which the streams have cut deep valleys through a long period of time. The Susquehanna River flows diagonally across the area from the vicinity of Lestershire to the southeastern corner. Its valley varies from one-half mile to nearly 2 miles in breadth between the steep walls. At Binghamton this stream is joined by the Chenango River, which nearly bisects the upper half of the area. The highest elevations in the area surveyed lie along the Pennsylvania line, where the hilltops range from 1,700 to 1,860 feet above sea level. The river valleys lie at an altitude of about 840 feet. The hill portion of the Binghamton area is well drained by a large number of small streams, which empty into the Susquehanna River or its tributaries. Along both the Susquehanna River and the Chenango River there are small areas, lying at a slightly higher elevation, subject to occasional overflow. There are found various bottom-land areas, the lower portions of which are sometimes overflowed. Within these valleys there are also extensive stream terraces lying at elevations of 30 to 80 feet above normal stream levels and constituting valuable lands. The low-lying bottom lands are also farmed, although crops are sometimes injured or destroyed by unseasonable inundations.

The consolidated rocks which underlie the soils of the Binghamton area consist of thin-bedded sandstones and shales of the Chemung and Catskill groups. The Catskill is only found in the extreme southern part of the area and on the highest elevations. These underlying rocks, while influencing the soil conditions of the Binghamton area, have not given rise to the soils directly. This region lies near the southern limit reached by the invasion of the great continental glacier which once covered the northern part of the United States. During this glaciation the local rock, both shale and sandstone, was thoroughly ground up at the surface, and this pulverized material was mixed with a considerable amount of earth and stones brought in by the glacial ice from regions farther north. The resulting soil of the upland therefore consists of a small proportion of material of other localities, mingled with a considerable amount of detritus from underlying rock. Scattered throughout this mass of soil material are numerous fragments and chips of the original rock of the region, and this combination of glacial material and of the local material gives rise to the chief upland soil type—the Volusia silt loam.

During the period when the glacial ice was melting, large volumes of water flowed from its surface and front, occupying the main gorges which had existed before glaciation occurred. As a result the clay, silt, sand, and gravel from the glacier and from the upland regions were mingled, reworked, and redistributed as a deep filling in bottoms of the main-stream gorges. Some material had also been dumped within these gorges as a direct deposit from the ice. This morainic material and the later deposits from the melting glacier give rise to the Dunkirk gravelly loam, the Dunkirk gravelly sandy loam, the Dunkirk fine sandy loam, and the Dunkirk silt loam. Within more recent times the overflow of the streams, as they now exist, has given rise to the deposition of a considerable amount of sediment of the more recent, low-lying bottoms, which constitute the Wabash loam. In the same way the torrential streams which descend from the uplands carry down materials which are deposited where the streams flow out upon the more nearly level surface of the valley floors. This material consists of large and small fragments of shale and sandstone and a considerable amount of finer material. This class of deposition has given rise to the Dunkirk shale loam. Poorly drained areas, both through the stream valleys and in isolated patches on the upland, have given rise to conditions favoring the accumulation of considerable amounts of partially decayed organic matter. These poorly drained areas have been mapped as Swamp and Muck.

The soils of the area have a complex origin, being formed partially from the ground-up country rock and partially from material brought into the region through glacial action. Some portion of this material has further been reworked, both by the glacial streams and by the streams which now exist, into terrace and low-lying soil. The Binghamton area is representative of a considerable section of country in southern and central New York, and the majority of the soil types encountered in this area are found both to the east and west along the southern tier of counties and also in the counties of northern Pennsylvania.

SOILS.

The soils of the area consist of one upland type, covering by far the greater part of the survey, and a number of terrace and valley types, forming the most productive farming lands. The upland soil is the direct result of a feeble glaciation of the higher hill country and is the product of the pulverization of a great variety of rocks of widely differing chemical composition and texture. Distinguishing characteristics of the type are the absence of definite structure and a generally compacted condition of the subsoil. The terrace and valley types usually show distinct stratification.

The following table gives the name and area of each of the types as mapped:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Volusia silt loam	118,976	81.2	Swamp	1,024	0.7
Wabash loam	9,280	6.3	Dunkirk fine sandy loam	832	.6
Dunkirk gravelly sandy loam	5,312	3.6	Muck	128	.1
Dunkirk gravelly loam	4,864	3.4			
Dunkirk silt loam	4,288	2.9	Total	146,560	....
Dunkirk shale loam	1,856	1.2			

VOLUSIA SILT LOAM.

The soil of the Volusia silt loam consists of from 4 to 8 inches of a brown, yellow or gray silt loam containing from 10 to 25 per cent of shale fragments ranging in size from less than a quarter of an inch to several inches in diameter. From about 6 to 18 inches there is usually a lighter colored band of material of about the same texture as the soil. The lighter color of this material would seem to be the result of a change in the iron salts. The subsoil is a yellow or mottled heavy silt loam of a very compact structure. In the field it appears of a finer texture than the soil, probably because of a weaker granulation and a higher percentage of moisture under average conditions. It contains a somewhat larger proportion of shale fragments than the soil, the range in size being about the same. In both the soil and subsoil there occur occasional large shale tablets and igneous bowlders. Many of these latter are granite.

This type is by far the most important, in point of extent, in the area. It constitutes 81.2 per cent of the area surveyed, and is the only type which occurs outside of the large valleys of the two main rivers, with the exception of very small bodies of swampy land in a few places and narrow bands of an alluvial loam along some of the small streams. It is divided into three main bodies by the rivers, and the slope of each is in general toward these streams. A considerable isolated body lies between Kattel Creek and the Chenango River. In addition to these main bodies of the type there are a number of smaller isolated areas in the Susquehanna River Valley between Binghamton and Lestershire and immediately north of Kirkwood Center. These have a very much less elevation, as is shown by the map, than the great bulk of the type, just emerging from the deposits that fill the valley to a considerable height. These areas appear to be the crests of a formation which underlie much of the alluvial material, and in fact some of the areas still have a thin covering of from a few to several inches of fine silty and fine sandy loam not unlike the soils which surround them.

The surface of the Volusia silt loam is all more or less rolling, and in many places is broken. The topographic features are best understood by reference to the accompanying map. It will be seen from this that the features are those of a high plateau region that has been subjected to excessive erosion. A very complete drainage system was developed before the area was invaded by glacial ice, and the rock formations had been carved into a system of divides of varying height and width, some with narrow and others with broad intervening valleys. The divides generally have moderately to rather steep valley walls, but with few exceptions there are no precipitous slopes. These natural erosion slopes have been modified by the subsequent glacial action that formed a considerable part of the soil material, and thus are less rugged and abrupt than would otherwise be the case. The divides are sufficiently level to permit most cultural processes to be carried on without serious hindrance, but many of the valley slopes are too steep to permit ready cultivation. The steeper areas are found throughout the type, but are more common in the southern than in the northern part of the area. On the more gentle slopes the soil covering is deep and of the average texture. On the very steep slopes the bed rock is comparatively near the surface, in some places only a few inches or a foot of soil being found. The soil here is more loose and friable, contains more stones than the remainder of the type, and is more uniformly dark colored from the presence of considerable quantities of organic matter. The subsoil is more uniformly yellow and shaly, owing to a greater proportion of purely residual material. These areas are indicated on the map by the stone symbol. They are largely covered with an inferior forest growth, consisting mainly of chestnut, hemlock, oak, and some pine. Where cleared they are used for pasture. On the more level areas of the type the same species of trees are found, but the growth is generally heavier. The native timber consisted of trees of these varieties, and the pine was particularly valuable. At present a relatively small percentage of the type is in timber, and this is all second or third growth.

The Volusia silt loam, as may be inferred from the character of the topography, has a very perfect surface-drainage system. Heavy rains are carried from the surface very rapidly by the many streams. The subdrainage is less perfect, as the dense character of the subsoil hinders greatly the movement of water—a condition often injurious to growing crops in several ways. On level or depressed areas the compact character of the subsoil is even more serious, and swampy conditions are likely to be developed. This is the origin of most of the areas of swampy lands that have been mapped in this type. The moisture that does succeed in penetrating the soil mass on the hills is in some cases led along the surface of the bed rock, appearing in the form of springs or seepage on the steeper slopes where the rock emerges. Springs of this sort are common and their flow is fairly continuous, although the volume fluctuates with the rainfall. The usual depth of wells on this type is from 20 to 30 feet. Artificial underdrainage would in many cases prove beneficial in the wet areas of this soil.

The Volusia silt loam has been derived through the action of glacial ice on a country formed of shaly rocks. The materials composing this soil are varied in character and thrown together without definite arrangement, though they consist very largely of the ground-up product of the local rocks. As is usually the case with glacial soils some foreign material was brought in by the ice, and all the soil materials were probably carried some distance before being deposited in their present position. The covering of glacial material was undoubtedly thinner on the uplands than in the valleys, and in the higher part of the uplands than elsewhere. Erosion, moreover, has removed more of the glacial débris from such places, hence the soil is more residual in character here than at lower elevations. The soil is also more stony, owing to the nearness of the bed rock. As is indicated by borings, the glacial till varies in thickness from 30 to 50 feet on the divides to only a few inches on the steep slopes and some of the highest elevations. In the large valleys it is doubtless much deeper than 50 feet.

All but a small part of the type is cleared, though only 6 or 8 per cent of it is in cultivated crops. Of these crops potatoes succeed the best and yield from 75 to 125 bushels per acre of tubers of good eating and keeping quality. However, potatoes are a good crop on this soil only by comparison, and the type is not to be regarded as a very desirable soil for their production. Corn is grown to some extent, but does not usually mature and is used for silage. The growth is short. Root crops are not grown extensively, and vegetables only in quantities sufficient to supply home demands. Wheat, very little of which is grown, yields from 12 to 20 bushels per acre. There is a larger production of oats, of which the yield ranges from 25 to 40 bushels. Buckwheat is extensively grown, from 10 to 20 bushels being the range of yield. A small acreage of rye is sown.

Of all the crops grown grass is best suited to the soil and climatic conditions, and a very large proportion of the type is occupied by hay meadows and pastures. As a rule these lands are not carefully seeded, and the stand is often poor and weedy, consequently the yields are low, ranging from one-half ton to 1¼ tons per acre. Timothy is the principal grass, and a considerable acreage of clover is also sown, though it does not succeed well under the natural conditions of the type. It heaves seriously in winter.

Small apple orchards are found about the farmsteads, and the trees make a fair growth. Plums and berries do well, but pears and peaches give indifferent results. On the whole, little attention is given to horticultural crops. The country occupied by this type is primarily a dairy and grazing section, and most of the farmers keep herds of from 5 to 30 cows, either selling the milk to cheese and butter factories or making butter themselves, or, where conveniently situated to railways, shipping milk to local markets and to New York. The important points in the management of this soil are the adoption of suitable crops and the improvement of the tilth by the incorporation of organic matter, for the lack of which the type is often compact and droughty. Grass and root crops are the chief resources of the farmers of this section of the area, and with these the seed should be of good quality and carefully sown on better prepared seed beds. Corn may be used for silage and should be rotated with leguminous crops where practicable. Combinations of the two make the best silage for dairy stock. This system of farming necessitates the keeping of considerable numbers of live stock, as is now done to some extent. The necessity for a carefully planned rotation can not be emphasized too much, nor can the farmers make a mistake in the use of more green manuring crops. In some areas the land should be underdrained. The depth of plowing should be increased to 8 or 10 inches once in five years, and in addition to organic manures, lime may well be used, say once in four years, and in quantities up to 1,500 pounds per acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Volusia silt loam:

Mechanical analyses of Volusia silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13874, 13878	Soil	4.4	5.3	0.9	1.5	6.1	55.5	26.1
13875, 13879	Subsoil	5.3	7.3	1.6	2.1	4.7	52.2	26.5

DUNKIRK SHALE LOAM.

The soil of the Dunkirk shale loam is a light-brown or yellow silty loam, 6 or 8 inches in depth, containing from 20 to 40 per cent of shale fragments. The subsoil consists of a loose mass of shale fragments varying in size from a fraction of an inch to 1 foot or more in diameter, with the interstices filled with a yellow silty to fine sandy loam. The shale fragments are generally less than 3 inches thick, and interspersed with them occur some limestone and occasional igneous bowlders. All of the rock fragments are much worn and rounded. The proportion of stone in the subsoil is usually 15 or 20 per cent greater than in the soil.

The Dunkirk shale loam occupies only 1,856 acres, or about 1 per cent of the area surveyed. It is found in small detached areas stretching along the foot of steep slopes from the upland, as at North Fenton, Kattelville, and Willowpoint; as a sort of delta formation at the mouths of small streams emerging from the Volusia silt loam, as at Stilson Hollow, in the vicinity of the State Hospital, and at a number of points along the east side of the valley of the Susquehanna, from Binghamton to the Pennsylvania State line; and in the bottoms of small valleys in the main body of the Volusia silt loam, as in the towns of Fenton, Vestal, and Binghamton.

The areas of this type in the large main valleys have the appearance of remnants of terraces and deltas, reaching outward from the walls of the valley and sloping moderately toward the streams. The slope on the side of the stream is as usual quite steep. The areas in the small upland valleys have a nearly level surface and show some terracing.

The drainage of the Dunkirk shale loam, with little exception, is good. This is due in part to position and in part to the loose, open character of the soil and subsoil. Those parts situated next to the steep slopes from the upland are likely to be poorly drained for a short distance from the base of the slope, owing to seepage from the higher lying lands. The Dunkirk shale loam is associated in origin with the drainage of the region during and since the recession of the ice sheet. It represents the wash of swiftly flowing streams which have deposited alluvial cones when their swift flow has been checked upon descending to level areas. It thus forms low alluvial cones and fans and consists of large and small stones loosely piled together. The interstitial loam is the result of the checking of mud-laden water as it moved through the porous rock mass. This is shown by the relation which the material bears to some of the finer textured types of soil, such, for instance, as the Dunkirk silt loam. Material of the same general texture as the Dunkirk shale loam passes under the Dunkirk silt loam in a number of places, and there is a very regular gradation upward from the shaly mass to the silty material at the surface. This may be observed in the cuts on the State Hospital grounds and at a number of places in the Susquehanna Valley. The high level area near Willowpoint probably represents the discharge of a superglacial stream.

The agricultural value of the Dunkirk shale loam is moderate. The more level bodies produce fair crops of corn, potatoes, and oats. Apples are found to grow well on some parts of the type, and berries also thrive. Grass, oats, and potatoes have in general been found to be the best crops on this soil. Timothy hay yields from 1 to 1½ tons, oats from 30 to 35 bushels, rye about 25 bushels, and potatoes from 75 to 100 bushels per acre. The soil is easily cultivated. It can be much improved by the use of organic manures. Near the city it is valued at $20 to $30 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Dunkirk shale loam:

Mechanical analyses of Dunkirk shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13856, 13858	Soil	7.5	8.6	2.4	8.1	16.6	35.2	21.4
13857, 13859	Subsoil	11.7	11.5	3.7	9.8	16.0	30.9	16.1

DUNKIRK GRAVELLY SANDY LOAM.

To a depth of about 8 inches the soil of the Dunkirk gravelly sandy loam is a light-brown or yellow sandy and silty loam. Between 8 and 15 inches the material grades into light loose gravel and coarse sand, which becomes more coarse and open and of a grayer color with increase in depth. Below 2 feet the formation is generally a loose gravelly sandy loam, which extends to a depth of 20 or 30 feet.

The areas of the Dunkirk gravelly sandy loam are distributed along the courses of the Chenango and Susquehanna rivers, the most extensive development occurring along the former and along the Susquehanna below the junction of the two streams. The areas sometimes extend some distance up the smaller lateral valleys. The cities of Binghamton and Lestershire are situated on areas of this type of soil. The most characteristic area is in the vicinity of Lestershire, where there is a shallow sandy soil, which grades into a coarse, loose gravelly, and sandy mass, highly variable in composition and plainly cross-bedded, which reaches to a depth of many feet. Gravel derived from the formation at this place is used for various economic purposes. The surface of this area is somewhat rolling.

The point of land on which the city of Binghamton is situated and the area of this type that extends north to Chenango Bridge constitute a phase of the type which is distinguished by having a yellow silty loam soil, in many places quite free from gravel and extending to a depth of 15 to 20 inches, below which the typical gravelly material is found. The surface is more nearly level than about Lestershire. Most of the Kattel Creek Valley area belongs to this phase. The upper part of the Kattel Creek area and the areas opposite Chenango Forks and in the Page Brook Valley constitute a third phase of the type. The surface here is more uneven and is made up of large lenticular ridges and of irregular kame and kettle areas. The ridges and knolls have a coarse sandy soil with coarse gravel near the surface and with a number of large bowlders distributed throughout the material. The intervening depressions have a dark loamy soil of considerable depth. All of this phase is coarser in texture than the other two phases, and the large bowlders are often so numerous as to be a serious hindrance to cultivation. The last two phases of the Dunkirk gravelly sandy loam approach the Dunkirk gravelly loam in texture, the second more nearly than the third; but they are to be distinguished from it by the much more loose and porous nature of the deep subsoil. The areas of the type along the Susquehanna above Binghamton have rather the character of the second phase.

The Dunkirk gravelly sandy loam is essentially a terrace soil formed from the wash materials carried in the swollen streams during the melting of the glacial ice. The elevation varies from 80 to 100 feet above the level of the present rivers, and the surface from level to irregular and rough. Parts of the original terraces have been cut away by recent erosion and in these places steep slopes have been formed. Such slopes are distinct around Binghamton and in a number of places higher up the Chenango River. In some places large channels cut through these terraces are now occupied by mere threads of streams, such, for example, as Brandywine Creek and the stream north of Lestershire.

The chief drawback to this type of soil is its excessive drainage. Being too porous to hold sufficient water to carry crops through a protracted period of dry weather, it is best suited to early maturing crops and to crops with root systems that penetrate deep into the soil. Trucking is followed extensively near the larger cities. In seasons of abundant rainfall all crops give good yield. In general, corn does fairly well and gives an average yield of about 40 bushels per acre; potatoes form a profitable crop on the more northern phase, producing from 100 to 150 bushels per acre; oats yield from 35 to 40 bushels; wheat, 15 to 20 bushels, and timothy and clover hay from one-half to 1 ton per acre. Cabbage grows fairly well on the heavier phases and such areas are most uniformly productive for crops in general.

In the matter of adaptation, deep rooting and early maturing crops must always prove the best for this type of soil. Once started alfalfa should grow well on much of the type. Where the surface soil is quite sandy, alfalfa should be protected by a nurse crop the first season to guard against the effects of excessive heat. The use of organic manure is recommended as a means of increasing and maintaining the supply of moisture.

The following table gives the average results of mechanical analyses of the fine earth of the soil and subsoil of this type.:

Mechanical analyses of Dunkirk gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13844, 13846	Soil	8.1	19.7	7.9	12.5	15.9	22.1	13.4
13845, 13847	Subsoil	9.7	27.4	13.4	12.9	7.0	15.6	13.7

In order to study the manurial requirements of this soil a sample was collected from a field which has been in cultivation many years. This field has been intensely cultivated and received large applications of manure.

The results obtained indicate that the productiveness of this soil may be increased very largely by the use of cowpeas as green manure; that the application of manure or lime will produce a fair increase; that nitrate of soda will produce a small increase, but that other mineral fertilizers will have little if any effect.

Wheat plants were used as an indicator in these tests, and the results are not held to be applicable to other unrelated crops, nor to fields which have received treatment essentially different from that from which the sample was taken.

DUNKIRK GRAVELLY LOAM.

The soil of the Dunkirk gravelly loam to a depth of 8 to 12 inches is composed of a dark silty and sandy loam mingled with from 15 to 30 per cent of well-rounded gravel and pebbles ranging in size from small particles up to gravel 6 inches in diameter. The subsoil is a dark-yellow or brown gravelly loam, somewhat sandy in places, with the gravel generally increasing in quantity with increase in depth. The quantity of gravel varies in different places from 15 to 60 per cent. All of it is rounded, and a great variety of rocks is present. Shale and limestone, however, are the most common.

The Dunkirk gravelly loam is closely associated with the Dunkirk gravelly sandy loam. It is a valley type, and is found in both the large river valleys and in the small upland valleys. In the latter it forms either the bottom adjacent to the stream or low terraces but a short distance removed from it. The material here is a mass of gravelly wash with silty and sandy loam filling in the interstices between the stone and forming a thin surface covering over them.

In the large river valleys the areas are generally more extensive and occur as lateral terraces or remnants of terraces. These areas range in elevation from 20 to about 100 feet above the river, and therefore correspond very closely in general position with the Dunkirk gravelly sandy loam. This part of the type must be regarded as having been formed at the same time and under the same general conditions as the other gravelly type, and is distinguished from it mainly by the much more loamy character of the soil and its consequent higher crop values. It grades into the Dunkirk gravelly sandy loam in many places, so that parts of the two types are very similar in character. The typical materials, however, are easily distinguished. In the Chenango Valley above Binghamton the soil varies from the type in having a silt loam soil containing very little gravel and ranging in depth from 10 to 20 inches over a large part of the area. The upper part of the soil has a characteristic dark color which changes to yellow with depth. It is essentially an overlapping of material of the Dunkirk silt loam on the gravelly formation. Below the silt the proportion of gravel gradually increases.

The topographic features of the Dunkirk gravelly loam consist of flat-topped terraces sometimes varied by low, rounded ridges and knolls, with moderate slopes near the edge of the terrace where erosion has been active. Along the river this type is frequently set off from the Wabash loam by a nearly vertical slope with a change in elevation of from 10 to 50 feet.

With very few unimportant exceptions the drainage is good. This is assured by the deep porous subsoil which permits the easy passage of water. The upland areas are likely to be flooded in times of high water, but practically none of the type in the main valley suffers in this way. The origin of the Dunkirk gravelly loam has been touched upon in the discussion of its distribution. It was formed from deposits left by swiftly flowing streams and may be divided into two phases on the basis of the time of formation. The upland areas and some of the low-lying bodies in the large valleys are of recent origin, while the remainder of the type is probably older and represents the deposits from glacial floods. The process of formation in the two cases has been essentially the same, and the resulting material is of nearly the same character and crop value.

Chief among the crops is corn, which yields on an average 35 to 45 bushels per acre, with larger yields in specially favorable seasons and under the best cultural methods. Potatoes do fairly well, and yield from 100 to 200 bushels. The more silty areas give fairly good yields of cabbage and tomatoes. Adjacent to the large cities the soil is used for trucking, and in seasons of ample rainfall gives good results. Small fruits, peas, beans, and other truck crops are grown. Cucumbers, squashes, and pumpkins are also satisfactory crops. For celery the type is not so well adapted. Hay crops in general are poor. Timothy and clover are short lived. While no alfalfa was seen, it is believed that on a large part of the type the conditions are very favorable for its growth, more favorable in fact than on any other type in the area surveyed. Manures and fertilizers have marked beneficial effects, and in all cases the results are best in moist seasons.

The following table gives the average results of mechanical analyses of the fine earth of this soil.

Mechanical analyses of Dunkirk gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13870,13872.......	Soil.........	2.5	4.4	2.4	21.1	25.0	29.6	14.5
13871,13873.......	Subsoil.....	6.0	10.8	3.0	18.4	21.5	27.4	12.6

For the purpose of ascertaining to what extent this soil would respond to treatments with manure and various chemical fertilizers, a large sample was taken at a point about 1½ miles north of Port Dickinson. The field from which the sample was taken had been in cultivation for over fifty years, during which time no mineral fertilizers had been used, and only medium applications of stable manure made. Notwithstanding the long period of cultivation and the fact that no fertilizers had been used, this field was in excellent condition and producing corn at the rate of 50 to 80 bushels per acre, potatoes at the rate of 200 bushels per acre, and hay at the rate of 1½ to 2 tons per acre.

The results obtained on this soil by the wire-basket test indicate that a small increase in productiveness may be obtained by the use of stable manure. Mineral fertilizers consisting of sulphate of potash, acid phosphate, nitrate of soda, and lime failed to produce any appreciable increase in the growth of plants, whether these ingredients were used separately or in combination. Wheat plants were used in this test, and to what extent the results are applicable to other crops and to fields which have received different treatments is a subject for further investigation.

DUNKIRK FINE SANDY LOAM.

The soil of the Dunkirk fine sandy loam is a brown or yellow fine sandy loam, about 8 inches in depth, and of rather silty character. It contains from 3 to 15 per cent of shale fragments and gravel. Below 8 inches the material is a yellow or dark-gray fine sandy loam, which becomes coarser in texture with depth, and is of medium grade at 36 inches below the surface. The subsoil material is usually underlain by a more gravelly stratum, except where it joins with the areas of Volusia silt loam, in which case it rests on the glacial till.

The Dunkirk fine sandy loam is found entirely in the valley of the Susquehanna River, and the main areas lie west of Binghamton. Other small areas occur southeast of the State Hospital. It has a medium elevation, occupying a terrace between the level of the Wabash loam and the gravelly loam types, and is generally associated with the Dunkirk gravelly sandy loam.

The surface has a gentle slope and the drainage is good, the chief deficiency from an agricultural viewpoint being the insufficient supply of moisture even in moderately moist seasons.

The material composing the Dunkirk fine sandy loam is an alluvial deposit, probably laid down at the same time as the gravelly loam types into which it grades. It represents deposition from much slower currents than gave rise to the coarser textured soils.

The Dunkirk fine sandy loam is of little agricultural importance for the reason that much of it lies within city limits. It is really the best early truck soil in the area, and is used for this purpose south of Lestershire. Corn, potatoes, cabbage, turnips, onions, and hay give from low to medium yields. The potatoes are of fine quality. Asparagus and lettuce do well. The crop-producing power is much increased by a generous use of organic manures and careful cultivation.

The following table gives the average results of mechanical analyses of this type of soil:

Mechanical analyses of Dunkirk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13860, 13862.......	Soil.........	1.5	5.3	4.1	26.1	25.1	26.3	11.3
13861, 13863.......	Subsoil.....	1.9	7.0	5.4	31.0	24.0	20.2	10.1

DUNKIRK SILT LOAM.

The Dunkirk silt loam consists of a brown or dark-gray silty loam 8 inches deep, underlain by a yellow silt loam. The soil is generally loose and friable, and the lower part of the profile is more dense and clayey. There are generally some shale fragments and gravel, ranging from 2 to 15 per cent, scattered through the soil and subsoil. Examination of a number of cuts shows that the silt is generally underlain by a shaly or gravelly material at a depth of from 2½ to 5 feet. In some of the areas lying in the western part of the survey the proportion of fine sand becomes more noticeable.

The gravelly or shaly material generally underlying the soil often outcrops on the lower slope, forming a narrow strip of gravelly or shaly soil. Since in most cases these are too small to be mapped separately they are included with this type. In the Kattel Creek Valley the material mapped as Dunkirk silt loam rests upon extensive gravel formations at a depth of 4 feet, and the surface soil gradually thins out toward the center of the valley without a marked change in the level until the gravel comes almost to the surface. The shaly strips along the borders of the areas of this soil type are of common occurrence in the Susquehanna Valley.

The Dunkirk silt loam forms second terraces in the large valleys at the foot of slopes covered by the Volusia silt loam. The elevation seldom exceeds 1,000 feet, this contour usually marking the upper limit of the type. Its elevation above the river level is therefore from 20 to 100 feet. It is distributed in rather elongated areas along the borders of the valleys of the Susquehanna and Chenango rivers, the greater extent in the former southeast of Binghamton. An area of some size occurs across the river from Chenango Forks.

In general the slope of the surface is from the upland Volusia silt loam toward the gravel and loam types along the river. The slope is not steep, the gradients ranging from 1 to 5 per cent, so that cultivation is in most cases easy. The drainage is not always good. Where the silty material is deepest the surface is generally more nearly level and there is a tendency for the water to collect. Some of the areas have a decidedly clayey subsoil, and this further retards subdrainage. In most instances this condition may be remedied by artificial drainage.

The Dunkirk silt loam is of alluvial origin, and seems to have been formed at the close of the glacial period through the deposition from slow-moving water of the finer grades of material. At that time the central part of the valleys was probably in most cases occupied by a mass of ice, which during the later periods, when the volume of water had diminished, deflected the drainage to the sides, and the materials were there deposited in the same way as additions are being made to the Wabash loam at the present time. The lighter color of the Dunkirk silt loam and the lower organic matter content may be attributed to the much longer period of oxidation and decay to which it has been subjected.

The Dunkirk silt loam is probably the leading trucking soil of the area, excelling the Wabash loam, which is nearly as valuable a soil for truck, mainly because of its better drainage. It is naturally a less productive soil than the Wabash loam, but on some of the well-managed truck farms, where manure and fertilizer are generously applied and cultivation is thorough, corn yields from 75 to 100 bushels; potatoes, 300 bushels; cabbage heavily, with 95 per cent of good marketable heads, and carrots, turnips, and beets in proportion. Tomatoes give yields of 600 to 700 bushels per acre, and asparagus is fairly productive. The celery grown compares favorably with the best produced in the area, whether grown on the Wabash loam or the Muck soils of this region, and in some respects is superior, since it is less damaged by rust. Under the best conditions onions yield from 500 to 700 bushels per acre.

On these intensively cultivated truck farms from 2 to 3 tons of hay is secured per acre, but these yields are far from being the average on the type. Probably the average yields on the type as a whole would be less than half as great. The higher figures show what may be obtained by the best cultural methods, and demonstrate among other things the efficiency of heavy applications of manures and painstaking cultivation. Nearly all the manure used on the truck farms is brought from the city and well fermented before use.

In addition to the crops mentioned, the berry fruits and apples give good results. Alfalfa was growing in two places on the type and apparently doing well. Good yields of sugar beets of high sugar content have been produced on this type of soil, but the crop is not grown at present.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Dunkirk silt loam:

Mechanical analyses of Dunkirk silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13850, 13854.......	Soil.........	0.4	2.2	1.1	7.1	19.5	50.9	18.7
13851, 13855.......	Subsoil.....	.5	2.3	1.6	8.9	21.2	49.5	15.1

WABASH LOAM.

The Wabash loam consists of a dark-brown or black loam to silty loam from 10 to 18 inches in depth, underlain by a dark-yellow fine loam, extending to a depth of several feet. The texture of the soil varies somewhat, owing to the presence of more fine sand in parts lying next to the streams and of finer grained and heavier materials along the bluffs and away from the streams.

The Wabash loam is a river and stream bottom type and is distributed throughout the survey. The most extensive areas lie along the rivers, but narrow strips occur on many of the smaller streams. The type is characteristically developed in the valley of the Susquehanna, west of Binghamton, and in the Chenango Valley as far north as Chenango Bridge. In the area southeast of the State Hospital the soil is composed of lighter colored material, is slightly heavier in texture, and has a greater elevation above the river than in the parts just mentioned. Opposite Langdon, in the town of Kirkwood, the material has the texture of a clay loam and is mottled or gray in color.

In general the surface is only slightly elevated above the mean water level of the streams—the range in elevation being from 3 to 30 feet—and is nearly flat. Some of the lower parts are scarcely above the water level, and a large proportion of the type is subject to overflow during periods of high water. The light-colored phase, already described, is not subject to overflow.

Because of its low position the Wabash loam is subject to poor drainage conditions, often making it unsuited for deep-rooted crops, while with other crops injury occasionally results from inundations. In most parts of the areas tile drains would be effective in correcting this condition, and particularly valuable in hastening the drying of the soil after floods. By reason of its more open texture and greater elevation that part of the type next to the stream is generally the better drained. Several islands in the channel of the river are sufficiently above water level to permit cultivation, and in some instances are farmed.

The Wabash loam represents the most recent alluvial deposits of the streams along which it occurs. It is well adapted to the production of corn, and under good management and with ample applications of manure and fertilizer it yields from 75 to 100 bushels per acre. The average yield is probably about 40 bushels per acre. The typical dark-colored soil is the most productive, although its moist, cool nature requires a longer season for the maturity of crops than is the case on the gravelly and sandy types, and crops maturing in the fall are therefore more likely to be injured by frosts. The yield per acre of oats is 40 bushels, of timothy and clover hay from 1½ to 3 tons, of onions from 500 to 800 bushels, and of carrots sometimes as high as 1,000 bushels. Cabbage and tomatoes give good returns, and celery and asparagus are grown with fair success. Early potatoes produce better than late potatoes, and yields of 300 bushels per acre are sometimes secured. One hundred bushels is probably not far from the average yield on the type as a whole. In the vicinity of Binghamton the Wabash loam is extensively used for the production of truck crops, and for this purpose commands a price of $150 to $250 an acre. More remote parts are valued at trom $50 to $100 an acre.

The only field of tobacco (Connecticut seed leaf) grown in the area in the season of 1905 was on this type of soil. It would yield about 1,600 pounds per acre. The tobacco, which was formerly grown more extensively, is of fair quality and grades largely as binder. The present output is used in the manufacture of cigars at Binghamton. Sugar beets were formerly grown extensively on this soil and with good results, both as regards the yield and the quality of the product. Their production has been discontinued because of the removal of the factory.

The following table gives the average results of the mechanical analyses of the soil and subsoil of the Wabash loam:

Mechanical analyses of Wabash loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13864,13866.......	Soil.........	1.2	1.8	1.1	5.1	18.6	50.9	20.8
13865,13867.......	Subsoil.....	.5	1.1	1.2	5.3	19.7	51.4	20.5

A study was made of this type of soil to determine its responsiveness to different manurial treatments, using the wire-basket method. The sample selected for this purpose was made up from samples taken from a field 1½ miles northwest of Lestershire. This field has been under cultivation for a long time, but no fertilizers except small amounts of stable manure have been used.

From the results obtained it was found that either manure or a complete fertilizer would give a fair increase in productiveness and that nitrate of soda and sulphate of potash combined would give results almost as good. Sulphate of potash and acid phosphate, nitrate of soda and acid phosphate, sulphate of potash alone, and lime alone gave only a very small increase, while cowpeas and nitrate of soda seemed to effect no improvement in the soil conditions.

MUCK.

A half dozen small bodies of Muck are found in the area surveyed. The material to a depth of 15 inches or more consists of a mass of black or very dark brown organic matter which in a moist condition is of a fine pasty consistency. Most of the material is so thoroughly decomposed that the original plant tissues can not be distinguished, and it is therefore in a fair condition for the production of crops.

The areas of true Muck are situated in the valley near Binghamton. In a number of areas mapped as Swamp the soil is of a very dark color, owing to the presence of large quantities of organic matter, but the accumulations are so shallow and contain such large proportions of inorganic material that the soil can not be properly classed as muck.

The Muck areas owe their origin to deficient drainage conditions, which favor a rank growth of aquatic and kindred plants and the accumulation of their remains in a partially decomposed form. While some attempts have been made to drain these areas, they have not been sufficiently thorough and more drains and outlets are required to put this soil in condition for the production of maximum crops. Without exception the areas of Muck are so situated that drainage is possible at a cost that would be economical.

The present poor drainage condition results in low crop yields, as well as in rather poor quality of the crops grown. Celery, onions, cabbage, potatoes, corn, and hay are the principal crops. Celery is subject to rust. Timothy is a profitable crop, yielding from 1½ to 2½ tons per acre.

SWAMP.

Areas of Swamp occur throughout the survey in small bodies associated with all the other soil types. They represent a condition of deficient drainage rather than a distinct soil difference. All these areas have considerable accumulations of organic matter at the surface, but in general the mineral constituents are like those of the surrounding types. The surface soil is generally a dark or black loam, rich in organic matter, beneath which occurs an impervious loam of varying texture. The cause of deficient drainage varies with the area. In the uplands the areas are depressed below the general level of the surface and receive more or less drainage water from the surrounding land. In the valleys many of the areas occupy abandoned river and stream channels, and while some of them contain water only during periods of rainfall, others are covered with water throughout the year.

None of the areas of Swamp are at present cultivable, and all require drainage if they are to be of any value except for a little summer pasture. Some areas could be drained at a small cost, but most could be reclaimed only at an expense which would hardly prove profitable.

AGRICULTURAL METHODS.

In the large river valleys within 6 or 8 miles of Binghamton the farms are devoted largely to the production of truck crops and small fruits. . In the valleys outside of this limit more grain is produced, and on the uplands, where the Volusia silt loam is practically the only type of soil, hay and dairy farming are the principal lines of agriculture.

As a rule the truck farmers follow better and more thorough methods than the general farmers. The soils used in the production of truck crops are usually more easily worked, the area cultivated is smaller, the profits per acre are larger, and the nearness of the cities enables the farmers to obtain large quantities of stable manure at low cost. All these factors tend to intensive practices and soil improvement.

A great variety of truck crops is produced and find ready sale in the local markets. Frequently two crops are secured from the same land in one season, early spring crops being followed by late fall crops, such as potatoes, cabbage, turnips, and in some cases celery.

The heavy draft on the soil in the production of such rotations, as well as the special requirements of many of the crops, makes necessary the careful cultivation of the soil and the use of large quantities of manures and fertilizers. The land is plowed to a depth of 6 to 9 inches and well pulverized, and where manure is used it is spread on the surface before plowing. Many of the truck growers employ teams regularly in hauling manure from the city, and the quantity applied ranges from 20 to 50 tons per acre. This manure is bought mostly from livery stables and contains a relatively large proportion of straw or other bedding material. A few near the city arrange for the dumping of the street cleanings on their land. The most careful growers ferment the manure in compost heaps before applying it to the land. Experience has shown that the liberal use of manure not only maintains the soil in good physical condition, but also increases its productiveness from year to year. Commercial fertilizers are used by some of the truck growers in quantities ranging from 100 to 1,000 pounds per acre, the maximum quantity only in special cases. Various complete mixtures are used, as well as single constituents. Nitrate of soda is frequently applied in the later stages of development of some crops, and is said to be especially helpful in the production of onions.

Celery is grown most largely on the Dunkirk silt loam, and late potatoes do best on this type; while for tomatoes, cabbage, and small fruits it is regarded as a very satisfactory soil. All of the early crops are planted on this type in preference to the Wabash loam, which is better adapted for onions and cabbage. On the gravelly soils the same crops are grown and much the same methods employed. The use of manure is particularly beneficial, as it increases the power of these soils to retain moisture, droughtiness being their main deficiency.

Onions are grown from the seed and thinned to about 1 dozen plants to the foot. Much hand weeding is required in the culture of this crop. In harvesting all the weeds and rubbish are removed from the land, the tops are clipped, and the roots cut with a shallow running blade attached to plow handles, when the onions may be raked together in windrows. They are generally left on the ground to dry, though a few growers spread them on racks under cover, which is said to give better results. Onions so cured and dried will weigh from 50 to 52 pounds to the bushel.

The truck farms range in size from 10 to 40 acres, and several of them have good-sized greenhouses in which lettuce and cucumbers are grown in winter. Six crops of lettuce and two of cucumbers may be obtained during the season. Two or three growers are engaged in the production of ginseng roots. These are grown under sheds consisting of frames 8 feet high covered with open lathwork. The Wabash loam and the Dunkirk silt loam are the soils used. The roots mature in seven years from the planting of the seed, and weigh from 6 to 8 ounces each. They are cured by drying and are worth at present $8 a pound.

In upland farms all but about 6 or 8 per cent of the land is kept in grass and used for grazing and for hay. Nearly every farmer keeps a few cows, the usual number ranging from 5 to 15, while in some cases the herds contain as many as 40. The area of cultivated land is limited to the small acreage sowed to corn, almost all cut for silage, a relatively unimportant acreage devoted to potatoes, and the practically negligible extent covered by a small garden grown to supply vegetables for home use. Potatoes do relatively much better than corn. The grass lands are seeded about once in three years with a mixture of timothy and clover, in the proportion of 4 quarts of clover to 8 of timothy per acre, the quantity of clover seed being smaller than usually recommended because of its high price and the fact that on this soil the plant is short lived. Almost all the hay is fed on the farm. A large number of farmers supply milk to cheese and butter factories at convenient points in the county. There is also a considerable number who make butter for sale in Binghamton and adjacent towns. This practice is also followed by those farmers who supply milk for the factories during the summer season and who have some cows that produce during the winter months. The manure produced in the upland sections is carefully preserved and generally applied to the land planted to corn. Very little commercial fertilizer is used, the average expenditure per farm in the whole county being only $7. Plowing is generally to the moderate depth of 4 to 6 inches and tillage operations in general are capable of improvement.

AGRICULTURAL CONDITIONS.

The leading truck growers in the vicinity of Binghamton are making money, though the larger number probably do not clear any considerable amount above their living expenses. In the uplands the farmers are said to be generally quite free from debt, but with net incomes usually less than in the case of the truck growers. Throughout the area the farms are generally well kept and improved with good buildings, the Twelfth Census giving the average value of buildings per farm for the county as $1,107. The average value of farm lands is $18 an acre. In the Volusia silt loam areas the price of land ranges from $8 to $35 and is very much lower than in the valleys. In the valleys from $30 to $150 is the general range, though in special cases the price has reached $250 for the Wabash loam in exceptionally good condition and advantageously situated with respect to markets. The price of small areas in good cultural condition is generally higher than for larger areas..

The tax rate on farm property is regarded as high. It ranges from $1 to $2 per hundred, and it is said that the land is frequently assessed at more than it would bring at a forced sale. All of the upland farm land has decreased at least half in value within the last twenty-five years, a decline due at least in part to its less productive condition. According to the returns of the last census, which, though given for the county as a whole, apply quite as well to the area surveyed; 95 per cent of the area of the county is in farms, the remaining 5 per cent being nonagricultural lands in cities or held for speculation. Seventy-four per cent of the area in farms is improved.

The average size of farms for the county is 94.6 acres. In the Volusia silt loam regions the farms range from 60 to 250 acres, with an average of about 140 acres. In the valleys, where truck farms are most common, many of the farms contain less than 40 acres, and the general average is less than 94.6 acres.

A little over two-thirds of the farms are operated by the owners. Where valley farms are rented a cash rental is commonly charged, the rate for good trucking land in some cases being as high as $20 to $25 an acre, and probably averaging 10 or 12 per cent on the value of the land. In the upland sections the farms are more often rented on shares, the usual basis being one-half the crop where the tenant pays half the seed bill and the taxes and furnishes the labor, tools, and machinery. In some cases the landlord furnishes the cattle, such as dairy cows, and feed for the work animals, and pays half of the fertilizer bill where fertilizers are used. Where a money rent is given in the uplands the rates range from 85 cents to $1.25 an acre and is commonly $1 an acre. The system of share farming has come into use through the difficulty of securing labor. It is a plan for securing interested labor. How little labor is employed is shown by the fact that the average expenditure per farm for this item is only $57 a year. The work is mostly done by the farmer, with the assistance of his family. Laborers are not generally hired by the month, though the wage for such hands varies from $18 to $25, with board and lodging. Scarcely any labor is hired in the winter months. In the summer season day laborers are to be had at $1.50 and board. Help is easier to secure on the truck farms because of the nearness to the city, and a considerable number of laborers are employed, both by the day and by the month.

The important crops of the area, their relative acreage, and the average production per acre, as shown by the Twelfth Census, are given in the table on the following page.

Principal crops, proportional acreage, and yields of leading crops for Broome County, N. Y.

Crop.	Proportion of farm lands occupied.	Production per acre.[a]	Crop.	Proportion of farm lands occupied.	Production per acre.[a]
	Per cent.	*Bushels.*		*Per cent.*	*Bushels.*
Truck crops	0.22	....	Forage	1.50	[b]6.43
Wheat	.23	16.6	Potatoes	1.74	91.00
Rye	.34	14.2	Oats	4.80	27.50
Corn	1.17	25.8	Hay	23.4	[b].94
Buckwheat	1.50	12.50			

[a] The average acre value of truck crops is $80.

[b] Tons.

This table shows that only 11.5 per cent of the area in farms is occupied by other crops than grass, and that a considerable larger area is occupied by oats than by all other grains. Also that the grain, forage, and root crops cover about one-half as much area as is devoted to the production of hay, and that the two classes of products taken together occupy a little more than one-third of the area in farms. The remaining two-thirds is devoted chiefly to grazing, but includes, of course, the woodland. Eighty-nine per cent of the total area covered by the crops designated in the above table is devoted to crops which are fed on the farm.

Animal products, chiefly dairy products, with some wool and meat, form the principal output of the area. The average value of live stock on the farm is $480 and of dairy products $260. A considerable quantity of milk is shipped to New York City from points on the Erie Railroad, which runs a number of special milk trains that gather milk all along the line through the State, some of it coming from as far north as St. Lawrence County. In regions too remote from the railroad to permit daily shipment the milk is made into butter and cheese. Some butter is made on the farm and sold to regular customers in the local towns, but most of the milk is taken by the factories. Butter factories are situated at Maine, Kirkwood, Glen Aubrey, and Glencastle. The cheese factory at West Windsor made 38,200 pounds of cheese in six months, from May to October, 1904, inclusive, and in the same year the factory at North Fenton made 160,000 pounds in a 200-day run. The cheese factories are said to give slightly better prices for milk than the butter factories.

In and adjacent to the valley the transportation facilities furnished by the two main lines of railroads are very good. The wagon roads in the valleys are generally good, and a number of the more important are macadamized. In the uplands the roads, all of them made of local materials, are kept in good repair, and are fairly satisfactory, and care is exercised in the maintenance of bridges. The roads are, however, very hilly, which makes it necessary to reduce the size of loads, thus greatly increasing the cost of marketing the products of this part of the area. Aside from this insurmountable drawback the facilities of marketing are good. The local markets show an active demand for the special crops, and there is, moreover, a large demand for all kinds of truck, dairy, and fruit products in the mining regions of Pennsylvania, only a short distance south of the area.

As a whole, the general agricultural conditions in the Binghamton area are better than in some other parts of southern New York, where much the same soil conditions are found. The number of vacant houses is very much less on the Volusia silt loam area than in some other parts of the State where the same type of soil prevails; in fact, very few abandoned farms are to be seen. The rural free delivery of mail has been very generally extended, as has also telephone systems, so that there is much less isolation in the rural districts than formerly.

SOIL SURVEY OF MONTGOMERY COUNTY, PENNSYLVANIA.

By HENRY J. WILDER, A. T. STRAHORN, and W. J. GEIB.

LOCATION AND BOUNDARIES OF THE AREA.

Montgomery County is situated in the southeastern part of Pennsylvania, where it is separated from the Delaware River on the southeast by the narrow county of Philadelphia and on the northeast by Bucks County. The county is bounded at the northwest corner by Lehigh and on the west by Berks County, while on the south it is separated from the States of Maryland and Delaware by Chester and Delaware counties. For two-thirds of its length Montgomery is separated from Chester County by the Schuylkill River. The county is rectangular in shape, twice as long as broad, and includes an area of 317,440 acres or about 496 square miles.

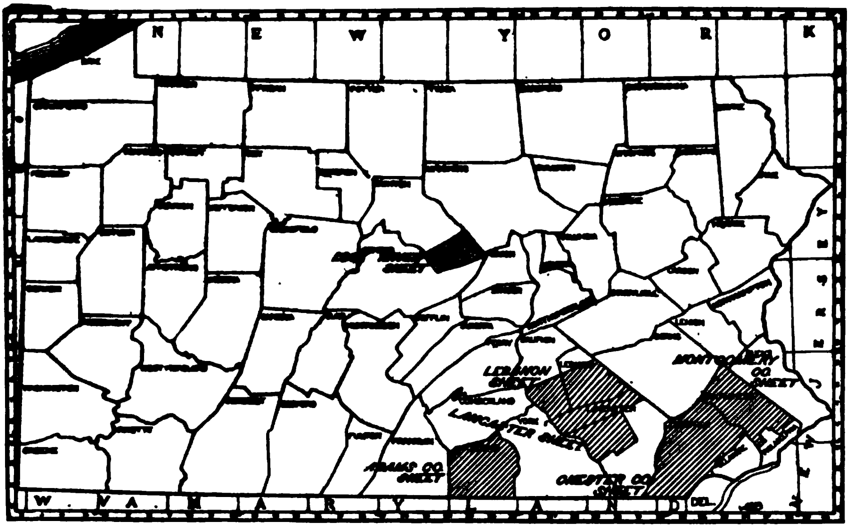

FIG. 3.—Sketch map showing location of the Montgomery County area, Pennsylvania.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The territory of Montgomery County was occupied by several of the Monsey or Wolf tribes of the Delaware Indian nation, from whom William Penn and his agents bought it with other neighboring tracts, in a series of parcel purchases between 1683 and 1697. For forty years prior to Penn's first purchase, however, the Swedes, Dutch, and English had engaged there in the beaver trade. The early settlers in order of priority were the Welsh, English, Germans, Swedes, and Scotch-Irish. The Welsh effected the first permanent settlement in 1682 in Lower Merion Township and for a time were the principal residents of both the Merion townships. The English, who were principally Friends, settled first in Cheltenham Township and occupied the central part of the county. The Germans, the most populous pioneer race, who still hold their own in numerical strength, first came from the Germantown colony in Philadelphia County and became the pioneer settlers of Perkiomen, Towamensing, Upper and Lower Salford, Hatfield, Franconia, Frederick, Marlboro, New and Upper Hanover, and Douglas townships in the northern and western parts of the county. With the Germans were a few Hollanders. By 1734 the German element formed more than half of the population of the county. The Swedes settled in the southern part, while the Scotch-Irish and a few French were scattered in the eastern part of the county.

At the opening of the Revolutionary war the log cabin and small clearing had given way to frame and stone dwellings. The several communities were connected by good dirt roads, and there were over 20 grist mills in the county. Valley Forge was built in 1751 on Valley Creek, and Pottstown was laid out in 1753.

With the war of the Revolution development was interrupted, but soon after that event it advanced rapidly. In 1784 Montgomery County was set off from Philadelphia County, of which, up to that time, it had been a part. In order of age it is the ninth of the sixty-seven counties of Pennsylvania. The dirt roads, up to this time the only means of inland communication, were not dependable for travel or for hauling farm produce to market, and a system of turnpikes was planned and constructed. One of these, the Lancaster turnpike, the first macadamized road in America, was completed in 1794. It reached from Philadelphia to Lancaster and for a part of the way passed through Montgomery County. Several other turnpikes were built and the great thoroughfares leading across the county from Philadelphia were soon intersected by public roads running from the Delaware to the Schuylkill River. Over these roads ran several lines of stages, and the old wooden bridges along these highways were soon replaced by more substantial ones of stone, many of which, having been rebuilt, are in present use.

For a decade after the war of 1812 there was much interest and activity in the construction of canals, which afforded cheaper transportation to market than the turnpikes did, and the opening of the canal to Philadelphia gave a marked impetus to the manufacturing interests. Several large furnaces and iron works were erected and agriculture flourished.

The land was heavily timbered with oak, hickory, and chestnut. Large quantities of wood were used at home for burning lime and for fuel, while supplying Philadelphia with wood constituted an important source of income to many farmers in the eastern part of the county. The stump lands were cleared and brought under cultivation by those of the farmers who were thrifty. Nearly everything needed for family use was produced upon the farm. Clothing was made from home-grown wool and flax. Hides were tanned at the local tannery, and nearly all articles of food were taken from the soil. From these beginnings the production of beef, pork, and mutton for the Philadelphia market came to be the principal agricultural industries. As competition in these products became keener with the development of lands farther west dairying increased until it became the most important branch of farming. Other products were wheat, oats, rye, buckwheat, corn, potatoes, vegetables, apples, and small fruits. The development has been very rapid since 1835, in which year the Philadelphia, Germantown, and Norristown Railroad (now a branch of the Philadelphia and Reading Railway) was opened to traffic. By 1880 the county was second in the State in the production of dairy products, a position which it has maintained to the present time.

CLIMATE.

The following table shows the normal monthly and annual temperature and precipitation for this section of Pennsylvania, as observed at the Weather Bureau stations at Quakertown and West Chester, which are located in counties adjoining Montgomery. The data given are believed to represent fairly well the conditions within the area surveyed:

Normal monthly and annual temperature and precipitation.

Month.	Quakertown.		West Chester.		Month.	Quakertown.		West Chester.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	In.	°F.	In.		°F.	In.	°F.	In.
January	27.4	3.37	30.0	4.03	August	70.2	4.31	71.9	4.36
February	20.7	3.98	31.2	4.28	September	63.7	4.03	64.9	4.37
March	35.6	3.80	37.8	4.48	October	52.0	3.38	54.0	3.75
April	48.2	3.08	49.2	3.70	November	41.1	3.36	42.8	3.96
May	59.2	4.39	60.3	4.62	December	31.5	3.38	33.3	3.93
June	68.3	3.32	69.5	3.97					
July	72.4	4.70	74.1	4.94	Year	49.2	45.10	51.6	50.39

In the following table are given the dates of the first and last killing frosts in the fall and spring, and also the average dates for the period between 1897 and 1904:

Dates of first and last killing frosts.

	Quakertown.		West Chester.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1897	Apr. 23	Oct. 4	Apr. 21	Oct. 31
1898	May 9	Oct. 17	Apr. 7	Oct. 28
1899	Apr. 22	Oct. 1	Apr. 11	Oct. 2
1900	May 11	Oct. 17	Apr. 11	Oct. 20
1901	Apr. 27	Oct 7	....	....
1902	May 29	Oct. 10	Apr. 4	Oct. 22
1903	Apr. 24	Oct. 25	Apr. 6	Oct. 27
1904	Apr. 4	Sept. 22	Apr. 4	Sept. 22
Average	Apr. 30	Oct. 9	Apr. 9	Oct. 17

PHYSIOGRAPHY AND GEOLOGY.

The physiographic features of Montgomery County are widely varied, and yet there are no elevations worthy the name of mountains, the highest hills being little more than 600 feet and most of them less than 500 feet above sea level.

The bed rock of most of the western two-thirds of the county is composed of the New Red (Triassic) sandstone of Mesozoic age, and as is usual upon this geological formation the surface for the most part ranges from gently to moderately rolling. The stream courses, which follow a northeast to southwest direction and flow into the Schuylkill River at the county boundary, have cut channels varying greatly in depth and width. Where the surface is nearly level the channels carved are wide rather than deep and at times of extended rains any low-lying land adjoining them is soon submerged. The fall is always sufficient to form a swift-flowing stream and at such times the narrow areas overflowed are in some places washed and in others left covered with sand and gravel, and the bridges are erected high above the streams and fastened by cables to prevent them from being carried away. Where the stream courses are deep cut, as is generally the case in the more hilly sections of the Dekalb shale loam, the banks of shale are so high that the streams do not overflow.

Away from the stream courses much of the area is slightly to moderately rolling. The elevations are, in the main, series of low ridges parallel to the streams. These ridges represent in some cases folds in the underlying sandstone, but more often they are uplifts of sandstone caused by movements in the underlying igneous rocks. The varying degree of this elevation is the determining factor in the contour of the areas between the streams of this formation. In places the uplift has been only slight. The igneous rocks have not come near enough to the surface for the heat to produce any material change in the overlying sandstone and the soils of the resulting low and well-rounded ridges do not differ essentially from those on each side. On higher elevations, where the intrusive material came nearer to the surface, the outlines are more pronounced, and the underlying sandstone, which shows metamorphism to some extent, begins to have an undesirable effect upon the soil. In the next stage the intrusive material has come sufficiently near the surface to metamorphose slightly even the uppermost layers of sandstone, which, as it disintegrates, fills the surface soil with shaly fragments. At this latter stage the line of the greatest stress of intrusion is so marked and well defined that the sides of the resulting ridge are steep and the apex sharp. The height of such ridges above their surroundings ranges from 30 to 100 feet. These elevations form both ridges and disconnected hills and in some sections follow one another in such succession as to leave very little level land and to constitute a very hilly region. The Perkiomen Hills are the most important area of this kind.

The final and complete stage of intrusion is seen in small areas where the dikes have reached the surface. This stage is best illustrated in Ringing Rocks Park and in the long, irregular, and broken ridges in the northwestern part of the county, where the igneous bowlders are so numerous as to form Rough stony land or Cecil stony loam on the hilltops, which are here usually elevated from 300 to 600 feet above their surroundings. Other analogous cases occur where the elevation is much less and where the dikes do not now reach the surface, but have left the soil of the Cecil series, sometimes containing particles and small pieces of the decomposing rock.

Succeeding the Triassic sandstone on the east, the most important formation is a limestone, which extends three-fourths across the county, though it is often separated from the Triassic formation by broken areas of Potsdam sandstone, which also bound it in places on both the north and east sides. The limestone occurs as a valley and is gently to moderately rolling within itself, while the Potsdam ridges along its borders are always moderately to very hilly.

The limestone valley or the Potsdam ridges, as the case may be, are succeeded on the east by igneous and metamorphic rock formations, first by syenite and granite with a little trap, then by schists, including small and scattered areas of serpentine.

The topography on these last-mentioned formations in the eastern part of the county differs markedly from that in the Triassic sandstone area west of the limestone valley. There are no large areas of level land, while most of the section is moderately rolling and marked here and there by steep little hills which have been worn down sufficiently to give them well-rounded outlines. These low hills are seldom lengthened into ridges and are small in area, but follow each other in close succession, giving to the country a most varied and pleasing general aspect, which, heightened by the many small groves of oak, hickory, and other hardwoods, proves exceedingly attractive to those wishing suburban residences near Philadelphia.

SOILS.

In this area seventeen soil types were recognized. Some of these pass so gradually one into another that it is rather difficult to determine their boundaries, while the boundaries of other types are sharply defined. The map which accompanies this report represents the various soils, distinguished one from another by different colors. The extent of each type is shown by the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Lansdale silt loam	93,888	29.7	Meadow	3,328	1.0
Dekalb shale loam	68,992	21.7	Lickdale clay loam	2,240	.7
Penn silt loam	61,824	19.5	Manor stony loam	2,048	.6
Chester loam	40,640	12.9	Dekalb stony loam	1,472	.5
Hagerstown loam	11,840	3.8	Conestoga loam	1,344	.4
Cecil stony loam	7,808	2.4	Manor loam	896	.3
Rough stony land	6,656	2.1	Chester mica loam	640	.2
Dekalb gravelly loam	4,800	1.5			
Chester fine sandy loam	4,608	1.4	Total	317,440	....
Cecil clay loam	4,416	1.3			

PENN SILT LOAM.

The surface soil of the Penn silt loam consists of red or reddish-brown silty loam from 8 to 12 inches deep. The subsoil is a heavier red or light-brown silt loam, grading usually into a red silty clay loam in its lower depths. The subsoil varies less in color than the surface soil, as its deep red seldom corresponds to the reddish-brown phase of the latter. In depressions, however, the subsoil is occasionally mottled with white. From 5 to 15 per cent of sandstone and shale fragments are frequently found in both soil and subsoil.

The Penn silt loam is associated with the Lansdale silt loam, and near the boundaries, where its color often grades for considerable distances toward the brown color of that type, the transition zone has been included in the Penn silt loam. In areas near the Schuylkill River there are several variations that consist of reworked material, but they differ more widely from each other than from the Penn silt loam, and so were mapped as a part of this type. In the elbow of the Schuylkill north of Valley Forge for some distance back from the river the type resembles a heavy phase of Penn sandy loam, as the soil consists of a heavy red fine to medium sandy loam containing

15 per cent of sandstone fragments, while the subsoil is of similar material. West of Port Kennedy along the main road leading to Valley Forge the soil is a brown loam containing considerable coarse sand, and in the vicinity of Royersford a similar brown loam contains considerable quartz gravel, while north from Port Providence are small stony and gravelly areas which have been designated on the map by symbol when of sufficient importance. In an area lying just west of Norristown and extending for a few miles north and northeast from the Schuylkill River, and in a few other smaller areas, the soil partakes somewhat of the nature of a clay loam, although containing a relatively high percentage of silt.

The main area of Penn silt loam occupies the north-central part of Montgomery County, extending thence southwesterly in two arms, of which the smaller reaches from Ambler through Norristown to near Valley Forge, and the larger through Worcester, Skippack, and Collegeville nearly to the Schuylkill River.

In topographic features the Penn silt loam ranges from slightly to steeply rolling, but most of the type is moderately rolling, and the included areas of level land are smaller than is general with this type. In some places the slopes to stream courses are gentle, but more often they are steep, and the consequent erosion of the soil leaves varying amounts of shale upon the surface. In many cases such areas are of sufficient size to be mapped as Dekalb shale loam. Again, the streams have cut their way through solid ledges of sandstone, leaving exposed cliffs nearly or quite perpendicular and from 10 to 40 feet high.

The drainage features of the Penn silt loam vary greatly. Where the texture of the underlying sandstone has been so nearly uniform as to prevent great variation in the rate of disintegration, the soil has accumulated to considerable depths and allows the moisture to percolate downward and at the same time holds in reserve a good supply for the needs of growing crops; but, on the other hand,where the underlying sandstone consists of alternate layers varying greatly in their powers to resist the processes of disintegration slopes are formed, generally parallel in their courses, and the tendency of the soil to wash causes it to collect in depressions or to be carried away by streams, thus preventing its accumulation on slopes and leaving the sandstone and shale fragments very near the surface in exposed positions. In such areas the water percolates rapidly through the fragments which overlie the bed rock and upon reaching the latter is obliged to flow in a lateral direction, thus causing seepage on the lower slopes, while higher up on the more exposed crests and hillsides crops suffer correspondingly from drought.

The Penn silt loam is derived from a sandstone of Triassic age. The greater part of this rock is red, but brown and yellow are also present, which accounts for some of the color variation in the type.

The Penn silt loam is best adapted to the production of the staple farm crops of the area—corn, oats, wheat, and grass—though the grade of wheat is generally considered slightly inferior to that grown on the Lansdale silt loam. The average yields are said to be: Corn, 50 bushels; oats, 30 bushels; wheat, 20 bushels, and hay, 1½ tons per acre.

The following table shows the average results of mechanical analyses of samples of the fine earth of the soil and subsoil of the Penn silt loam:

Mechanical analyses of Penn silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13656, 13658, 13660.	Soil.........	1.5	4.6	2.3	4.6	8.2	57.4	21.0
13657, 13659, 13661.	Subsoil.....	1.6	5.4	2.6	4.8	5.7	50.5	29.3

In order to ascertain the manurial requirements of this soil, a large sample was collected 1 mile west of Lansdale. The soil at this point, consisting of a heavy red silt loam with some fine rock fragments, was sampled to a depth of 8 inches. The farm from which the sample was taken has been in cultivation from fifty to one hundred years, but little information was available concerning its previous treatment.

The results obtained on this soil by the wire-basket method indicate that a moderate increase in productiveness can be secured by an application of cowpeas and lime, of stable manure, or by a combination of nitrate of soda and sulphate of potash. Nitrate of soda alone or in combination with acid phosphate produces a very small increase.

These tests were made with wheat plants as an indicator, and are held to be applicable only to the field from which the sample was taken. They are, however, in accord with the practice followed in the area in using stable manure extensively, but seem to indicate that small benefit is derived from the use of lime alone.

LANSDALE SILT LOAM.

The surface soil of the Lansdale silt loam consists of brown, drab, or light slate-colored silt loam. Much of the type contains sufficient clay to give it the characteristics of a heavy silt loam, and in some cases a silty clay loam, yet the silt content is so high that any clods formed through plowing the soil when too wet readily crumble upon drying, leaving the surface mellow and in good physical condition.

The subsoil ranges from a heavy silt loam to a silty clay always lighter colored than the soil and generally drab or pale yellow. This material packs firmly, and yet the proportion of silt is sufficient, notwithstanding the low content of the coarser soil particles, to cause it to break up very readily, and the type is often spoken of by farmers as being less clayey than the Penn silt loam.

In the large area of Lansdale silt loam between Lansdale, Ambler, and Willow Grove, in the northeast part of the county, the type is generally uniform in texture, and in topographic features is slightly rolling. Parallel ridges and slopes are less prominent than in the Penn silt loam, and areas level, or nearly so, are of greater extent. In the broken and irregular areas extending back from the Schuylkill River in the western half of the county, the type presents some minor variations, most of which are caused by partial reworking along the river front. As with the Penn silt loam in similar position, these variations are heterogeneous in character and small in area, no one of them being of importance in itself. These variations include near Oaks narrow small ridges of sandy loam, filled with sandstone fragments, and about 3 miles southeast of Royersford on a steep slope a brown loam containing from 10 to 20 per cent of fine gravel. In spots the subsoil is a sandy loam containing from 30 to 50 per cent of very fine gravel, and again a clay loam with a like gravel content. In the latter case the subsoil is similar to that of the Dekalb gravelly loam, except that the gravel is much finer. North and east of Pleasantrun, and, in general, along the ridges running northwest from Green Lane, the Lansdale silt loam is a little heavier than is typical. The subsoil is inclined to be soggy and these areas are somewhat less productive than the normal type, and in addition are not as well farmed as the type is elsewhere.

In the western part of the county the topographic features are more broken than in the more continuous area already described, and correspond more closely to those of the Penn silt loam. In the northwestern part of the county the Lansdale silt loam is closely associated with the Dekalb shale loam, and the topographic features are more diversified than elsewhere in the type. Level areas are small and the many corrugations in the underlying shale caused by intrusive dikes, which in some cases reach the surface but in others are buried beneath it, have rendered most of the surface from moderately rolling to hilly, and at the same time the shale has been so broken up and placed in exposed positions where the soil could not accumulate to any great depth that Dekalb shale loam has been formed, thus causing the areas to be very irregular in shape and occurrence. Such topography causes the soil to wash somewhat and in the depressions the accumulation of the fine material has formed a clay loam. Only a few of these areas are large enough to appear on the map, but where of sufficient extent they have been mapped as Lickdale clay loam.

Drainage conditions are generally well established on the Lansdale silt loam, and with the exception of depressions the soil gets in good working condition soon after a rain. At the same time the type maintains a favorable moisture supply for growing crops.

The Lansdale silt loam is derived from Mesozoic sandstone and shale principally of brown and gray color, but yellow, green, blue, and black are also in evidence.

The Lansdale silt loam is well adapted to all the general farm crops grown in the county, and with generous treatment may be made very productive. It is the best soil in the area for the production of potatoes, bringing a good yield of smooth tubers, and it likewise excels for wheat, giving a good yield of the best quality of grain produced in this part of the State.

The average crop yields are estimated as follows: Corn, 55 bushels; oats, 30 bushels; wheat, 22 bushels; potatoes, 100 bushels, and hay, 1½ tons per acre.

The following table shows the average results of mechanical analyses of the fine earth of samples of soil and subsoil of this type:

Mechanical analyses of Lansdale silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13662, 13664	Soil	0.2	1.6	1.1	4.5	5.1	68.2	19.1
13663, 13665	Subsoil	.4	1.0	.9	3.5	5.4	65.7	23.0

The manurial requirements of this soil were investigated by the wire-basket method, using a large sample taken 1 mile northeast of Spring House. At this point the soil to a depth of 7 inches consists of a brown silt loam.

The field from which the sample was taken has been under cultivation for over 100 years, the chief crops being corn, oats, wheat, grass, and sometimes potatoes. The usual rotation is a five-year one, in which corn, oats, and wheat are grown one year each in the order named, followed by two years in grass. When potatoes enter the rotation the time is extended to six years. Commercial fertilizers are used on corn and potatoes at the rate of 150 to 200 pounds to the acre, and manure is applied for the small grain and grass at the rate of about 5 tons an acre.

The results obtained by the wire-basket method indicate that a moderate increase in the growth of crops can be obtained by the use of sulphate of potash and nitrate of soda, and that equally as good effects may be produced by the practice of green manuring and liming. Of the mineral fertilizers sulphate of potash is the most effective, producing a moderate increase in the growth of plants even when used alone. The addition of nitrate of soda increases the growth slightly, while acid phosphate seems to have little or no effect. Lime used either alone or in combination also produces a moderate increase in growth. The effect from stable manure was rather small, but would probably prove more pronounced in field practice because of the marked beneficial physical effect that it exerts under the latter conditions.

These results are held to be applicable only to the field from which the sample was taken. They are, however, in accord with the practice of the community and, except in case of stable manure, which is equally as effective in practice as the mineral fertilizers, they will probably be found to hold in a general way for most of the type as it occurs in this area.

DEKALB SHALE LOAM.

The surface soil of the Dekalb shale loam where typically developed consists of slate-colored or blue-brown silt loam or silty loam from 6 to 10 inches deep. In places where the silt content is insufficient to constitute a true silt loam the amount of silt present is always enough to give to the soil a distinctly silty character, and at the other extreme the silt content may be exceptionally high, the soil containing but a very small proportion of other grades of soil particles. This latter material when dry seems extremely light and fluffy, but when thoroughly moistened it is so heavy as to give the superficial field appearance of a heavy clay loam. If worked in this condition clods are formed for the time being, but upon drying these readily crumble beneath the cultivator. The process is much facilitated by the presence of from 10 to 50 per cent of shale particles and small sandstone fragments, which are found on the surface and mixed with the soil. The shale and sandstone fragments are sometimes about evenly distributed over the surface and through the soil, but more often the amount varies widely in different parts of the same field. In general, the shale content follows somewhat closely the topographic changes, the most level positions and gentle slopes having much less than the tops and slopes of steep ridges, which, on account of their exposed position, have lost a considerable part of their surface soil from erosion. Small erratic areas with a very high shale content are frequently found, however, in almost every topographic position within the type, and a more advanced stage of the same geological occurrence is seen in the small and scattered areas which in places are strewn with flat, flaggy sandstone fragments from 3 to 8 inches in length, or again where lesser amounts of these fragments are mingled with the shale.

The subsoil consists of silt loam or silty clay loam, which in rare instances grades into a silty clay. The color of this material is nearly always of a little lighter shade than that of the soil. The shale content of the subsoil includes a wide range and determines very largely the local productiveness of the type. Where the topographic position is such that the agencies of erosion have not washed away the soil nearly as fast as formed, it has accumulated to a depth of from 2 to 4 or more feet and has mingled with it from 20 to 70 per cent of shale and small sandstone fragments. Beneath this subsoil is a mass of shale and sandstone fragments which immediately overlies the parent bed rock. In more exposed positions where the soil has been eroded away in varying degree the mass of underlying shale and broken rock is correspondingly nearer to the surface, and in extreme cases it is not possible to bore to a depth of more than 6 inches.

In the western part of the county there are small areas which may be properly designated as the stony phase of the type. Here the soil is a bluish-gray or slate-colored silt loam from 6 to 10 inches deep, grading into a slate-colored silt loam or silty clay loam usually containing a high percentage of shale particles, which in turn is underlain at depths ranging from 12 to 24 inches by a mass of shale particles and fragments. The stones and bowlders on the surface are of two kinds and correspond to the topographic position of this phase of the type. Where igneous rocks have been intruded through the Mesozoic sandstone, thus forming hills and ridges and giving rise to Rough stony land or Cecil stony loam on the summits and upper slopes, the lower slopes are strewn with bowlders which have been overplaced from nearer the crests above them. In no case have these igneous bowlders, which range in diameter from 3 to 7 feet, had any material effect on the formation of the soil. At a lower point on the slopes than that just described the intrusion of the igneous rocks has metamorphosed to some extent and brought to the surface the original sandstone bed rock which by the uplift and further weathering has been broken into flat flaggy fragments seldom more than 1 inch thick or larger than one's hand, but so numerous in spots that no soil can be seen. In a few cases the igneous material has failed to reach the summits of hills and ridges, but has lifted the heated sandstone to the surface over which its fragments are strewn. In addition fine shale fragments are present in some localities.

A red phase of the Dekalb shale loam is occasionally found in small areas where the soil has the same color as the Penn silt loam, and the shale content is likewise colored red. Though its field appearance is so dissimilar, this material does not differ essentially from the rest of the type in crop value.

The Dekalb shale loam is the most extensive soil type in the west third of Montgomery County, where it occurs for the most part in very irregular areas associated with the Lansdale silt loam. Its surface is much further broken there by a long Y-shaped intrusive dike of igneous rocks with corresponding soils. Another long and narrow area near the center of the county extends from the Schuylkill River easterly to Eagleville and thence northeasterly to near North Wales.

The topographic features of the Dekalb shale loam are most varied. Areas of level land are of small extent, and in general the type consists of a series of long and narrow ridges or a succession of rounded hills and short ridges which sometimes are so grouped as to form quasi ridge systems.

Drainage features are well established on much of the Dekalb shale loam, yet the type includes diametrical extremes in moisture conditions. Where the topography is only moderately rolling and the underlying bed rock is well broken up and disintegrated to a considerable depth the type is not only well drained, but also retains a favorable supply of moisture for growing crops, but in steep positions where the underlying rock comes near the surface or is in nearly vertical position the soil is very susceptible to drought, and good crops are seldom secured. On the other hand, when the bed rock is near the surface and lies in a nearly horizontal position there is no chance for the moisture to percolate downward, and so it in time escapes laterally, causing seepage on the adjoining slopes, which are thus kept in a soggy and untillable condition much of the time. This latter class of hilltops and ridge tops is thus much too wet after any heavy rain, and yet is very susceptible to drought.

The Dekalb shale loam is derived from shale and sandstone of Mesozoic age. Most of this rock is in place, but parts of it have been metamorphosed somewhat by the heat generated by the more or less complete intrusion of underlying igneous rocks.

In its adaption to crops the Dekalb shale loam varies. In steep positions where the soil is thin it is not well adapted to the production of any crop and low yields are the rule, while on slopes subject to seepage the type is best adapted to permanent pasture. In the more favored topographic positions, however, the type is fairly well adapted to the general farm crops of the area, and in many instances where properly drained Lansdale silt loam is not available, potatoes can be grown on the Dekalb shale loam to advantage.

All the general farm crops of the area are grown on the type, and the average yields are estimated as follows: Corn, 40 bushels; oats, 25 bushels; wheat, 15 bushels; potatoes, 100 bushels, and hay, 1 ton per acre.

The following table shows the average results of mechanical analyses of samples of the fine earth of soil and subsoil of this type:

Mechanical analyses of Dekalb shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13666, 13668, 13672.	Soil.........	4.1	5.7	2.1	2.5	3.3	58.5	23.5
13667, 13669, 13673.	Subsoil.....	1.7	4.8	1.9	2.6	3.7	59.1	26.0

LICKDALE CLAY LOAM.

The surface soil of the Lickdale clay loam consists of gray clay loam or heavy light-gray silty loam to clay loam to an average depth of 10 inches. The subsoil ranges from silty clay loam to silty clay, usually mottled gray in color, but sometimes the gray is mottled with yellow.

The Lickdale clay loam occurs only in scattered areas, and its topographic features include depressions in which drainage is too well established to be classed as Meadow, and adjoining gentle slopes, and occasionally the type extends over flat-topped hills.

The type owes its origin to the Mesozoic sandstone, but most of the surface soil has been formed by the washings from slopes of adjacent soils. It is well enough drained, so that fair crops of corn, hay, and the cereals are grown upon it, but much of it would be improved by artificial drainage. The type is best adapted to the production of hay and to serve as permanent pasture, though moderate yields of corn and the cereals may be obtained.

The following table shows the results of mechanical analyses of samples of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Lickdale clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13652............	Soil.........	0.9	3.3	1.8	2.7	6.1	59.4	25.7
13653............	Subsoil.....	.2	.6	.4	.9	4.1	58.0	35.5

CHESTER LOAM.

The surface soil of the Chester loam, where typically developed in large areas, consists of mellow brown silty loam from 8 to 12 inches deep. The immediate subsoil is most often a heavy silty loam, light ashy brown or yellowish brown in color. This character of material usually extends to a depth of 36 inches or grades into silty clay loam of reddish color at depths ranging from 18 to 36 inches, but in rare instances it is lacking altogether, and the surface soil is underlain immediately by clay loam. The surface of the greater part of the type is practically free from stones, but on small areas fragments of the derivative rocks are found to the extent of from 20 to 40 per cent, and on steep slopes of small areas such occurrence may be sufficient to constitute a very stony loam. Flat or angular fragments of gneiss seldom larger than one's hand are the most common variety, and in the subsoil the amount of these is often sufficient to prevent boring. These stony areas usually occur on the slopes where the amount generally increases with the steepness of the pitch or on steep knolls and little hills.

The Chester loam is the principal soil type in the eastern part of the county, where its proximity to the city of Philadelphia has made much of it very valuable. For this reason its range of variations is given in considerable detail in the order of their importance. The type includes many small areas of Cecil clay loam. The occurrence of such areas is very irregular, but in some places they are sufficiently numerous to form an almost constant feature. Their topographic position is diverse—slopes below the typical Chester loam, hilltops, or little valleys. The extent of such areas is seldom more than a few acres, and their manner of occurrence with the Chester loam is such that their separation from that type is rarely feasible. In Lower Merion Township, a half mile south of Arrowmink Creek and east from the main macadam pike, the soil is a very fine mellow loam, underlain at 10 inches by yellow silty loam, which grades into yellow silty clay loam at a depth of 24 inches. Southeast of Ardmore areas of fine loam are frequently found, where they represent a gradation soil between the typical Chester loam and the Chester fine sandy loam. Soils as mellow as this fine loam phase are rarely seen. Northeast from Camp Hill, on top of the ridge and for a short distance down the slopes, the typical loam gives way to a heavy fine sandy loam. This material is derived probably from Potsdam sandstone, which outcrops in places along the summit. Similar small areas of heavy fine sandy loam occur just east of Willow Grove. Between Valley Falls and the east county line, extending north from the largest areas of Chester mica loam, the soil contains considerable amounts of finely divided mica. The soil here is derived from a schist containing less mica than that which gives rise to the Chester mica loam, and the content gradually diminishes, until true Chester loam is the resulting soil beyond a distance of 2 to 3 miles.

The topographic features of the Chester loam are moderately to steeply rolling, and though hillsides too steep for easy cultivation may be seen, they are usually of small extent. Such areas exist in two positions—where small tablelands or other elevations break off sharply to stream courses, which in some instances have been cut deeply, or on the pinnacles, narrow ridge tops, or steep upper slopes of dikes in various stages of intrusion, or on similar elevations of Archean rocks. Most of the hills, ridges, and knobs, however, are weathered to sufficient depth to have passed the stage of sharp outlines, and where not broken by the sharper elevations of the Cecil or Dekalb stony loams now give to the area a smooth and well-rounded appearance, and thus but little of the type is too steep for economical cultivation.

Adequate superficial drainage is secured for most of the type by its topographic features, while the texture of the subsoil is such as to maintain a favorable moisture content for growing crops. Along lower steep slopes, however, where the stiff lower subsoil causes seepage, and also in minor depressions, the type is poorly drained.

The Chester loam is derived in different localities from granite, and from schists, gneiss, and other metamorphosed rocks. In the large areas the soil has been derived from the weathering of these rocks in situ, while in the long and narrow detached areas the soil is derived from the weathering of the intrusive material, which in that position is largely syenite and trap. In this latter position the resulting soil is much less productive than in the large areas.

The Chester loam is well adapted to general farming purposes, and excellent yields of the staple crops—corn, oats, wheat, and grass—may be obtained under efficient management. A large part of this type, however, is beyond the realm of practical farming. Proximity to Philadelphia and the natural scenic and topographic features of the type make it peculiarly attractive for residential purposes—both suburban and country estate—and as a result much of it is held at from $500 to $5,000 an acre and even more, depending upon location. Even at these prices there are still many holdings of from 25 to 100 acres each, occupied either by a wealthy class or held by land speculators and suburban developing companies. Where controlled by the latter the property is rented for one year at a time and so exhausted as rapidly as possible. Some of the wealthy residents buy large quantities of manure from the city, or keep large herds of cattle, and so maintain their land in a productive condition, and the farmers who still own and manage their farms get excellent yields.

The soil is naturally very productive and formerly brought large yields of the staple farm crops. With good management the average yield of wheat is 25 bushels, corn 50 bushels, rye 20 bushels, potatoes 100 bushels, and hay 2 tons per acre. For farming purposes the type is worth from $100 to $150 an acre.

The following table shows the average results of mechanical analyses of the fine earth of soil and subsoil of this type:

Mechanical analyses of Chester loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13041, 13640	Soil	1.6	6.1	3.8	9.5	8.1	42.6	23.1
13042, 13641	Subsoil	1.4	6.1	3.8	9.1	7.9	45.5	26.0

In order to obtain information regarding the manurial requirements of this soil a large sample was collected 1½ miles south of Conshohocken. At this point the soil is a brown, mellow loam, slightly micaceous and containing from 2 to 5 per cent of rock fragments. The sample was taken to a depth of 8 inches.

The field from which the sample was taken has been in cultivation fifty or sixty years, and brings fair average yields of the field crops of this section. In 1898, 1899, and 1900 it was timothy, the last crop being light. In 1901–1903 it was planted to corn, a top dressing of 10 tons per acre of fresh manure being used for fertilizer. In the fall of 1904 it was sowed to rye, yielding a fair crop. In 1905 it was planted to potatoes, 500 pounds per acre of fertilizer, which analyzed 5/3/3, being used.

The result obtained by the wire-basket method indicated that an application of complete fertilizer composed of nitrate of soda, sulphate of potash, and acid phosphate with lime will give a medium increase in productiveness, and that the complete fertilizer alone will produce almost as favorable results; that sulphate of potash and acid phosphate, nitrate of soda and acid phosphate, nitrate of soda and sulphate of potash will produce a small increase in productiveness; while manure, cowpeas, and lime, lime alone, sulphate of potash, and nitrate of soda alone will produce only a very small increase.

Wheat plants were used in this test, and while the results are held to be applicable only to the field from which the sample was taken they will probably apply to general farm crops over a large part of the area covered by this type of soil. It is also believed that if applied to a soil which is in a lower state of cultivation all the treatments would give relatively better results.

CHESTER FINE SANDY LOAM.

The surface soil of the Chester fine sandy loam in its typical development consists of brown or yellow fine sandy loam 8 inches deep. The character of the surface material, however, depends largely upon its topographic position. On level areas or on upper slopes the soil is a fine sandy loam or loamy fine sand which often contains small amounts of organic matter, giving it a light-brown or slate color to a depth of a few inches. On lower slopes the soil usually consists of yellow fine sand containing almost no organic matter. In steep positions the content of small stones is often sufficient to prevent boring, although there are no stones of consequence on the surface.

The subsoil consists of fine yellow sandy loam to a depth of 36 inches, except in the above-mentioned fine sand phase, which has a corresponding subsoil of fine yellow sand. The subsoil often contains a sufficient amount of small rock fragments to prevent boring at a depth of 20 inches or below. In small local areas the type is distinctly micaceous, forming a fine mica sand. Such areas have been derived from mica schist rock.

The Chester fine sandy loam occurs principally in Lower Merion Township. There is also an area near the Schuylkill River southeast of Conshohocken and another area along the east slope of the hills at Valley Forge.

The topographic features of the Chester fine sandy loam are moderately to steeply rolling. The moderately rolling areas are usually flanked by steep slopes of ravines leading to small stream courses, and the largest area of the type occupies this position along Mill Creek.

The topographic features for much of the type are conducive to rapid surface drainage, and the texture of the subsoil is sufficiently open to allow the rapid percolation of moisture even on the most level areas, and consequently the soil is very susceptible to drought. This characteristic is particularly noticeable on the lawns of some valuable suburban estates, where the grass dies out unless thoroughly watered, and so the type proves an exacting soil for the maintenance of good lawns.

The type is derived principally from the Philadelphia and Manayunk schists, and to a lesser extent from the Chestnut Hill schists.

Where the topographic position is suitable, the Chester fine sandy loam is adapted to the production of early garden crops, and its position relative to Philadelphia would make the more level parts of the type valuable for this purpose, but its nearness to the city and its desirability for suburban estates has so enhanced its value that it is often sold at prices ranging from $2,000 to $6,000 an acre, and so very little of it serves any agricultural purpose.

The following table shows the results of mechanical analyses of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Chester fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13642	Soil	0.9	7.2	7.9	24.3	14.4	27.5	17.8
13643	Subsoil	2.2	6.6	6.7	23.0	11.1	34.2	16.2

DEKALB STONY LOAM.

The surface soil of the Dekalb stony loam consists of yellow or light-brown, fine sandy loam to an average depth of 6 inches. The subsoil is a fine sandy and silty loam which usually grades into light clay loam at depths ranging from 2½ to 4 feet. From 30 to 70 per cent of sandstone and quartzite fragments are present on the surface and mingled with the soil, thus making it seldom possible to bore below a depth of 6 to 10 inches.

The Dekalb stony loam occurs only in small areas in the eastern and southern parts of the county. The most important areas include a prominent ridge which extends through Edge Hill and Hillside, and some detached hills near Willow Grove. Other areas lie south of the

Schuylkill at Rosemont, near West Conshohocken, and at Valley Forge.

The topographic features of the type are always rough and steep, and such characteristics, together with the sandy texture of the soil, cause drainage to be very rapid and excessive.

The Dekalb stony loam is derived from Potsdam sandstone, locally known as Edgehill rock. The type is not well adapted to any agricultural purpose and should be left in forest. The prevalence of chestnut trees in the natural forest growth has caused much of this type to be designated as "chestnut ridges."

The type is cultivated only in small areas adjoining other types, and crop yields are low. In the vicinity of Hillside and Edge Hill the type is very valuable, because of the desirable residence sites it affords.

CHESTER MICA LOAM.

The surface soil of the Chester mica loam consists of loose, brown silt loam 8 inches deep, containing a large amount of finely divided mica particles, and in patches where the parent rock lies near the surface there are considerable quantities of larger mica flakes. The subsoil is a heavy yellow silty loam or silty clay loam containing in its upper layers more mica than the surface soil, and at varying depths grading into a mass of mica particles. The mica content is sufficient to give to the surface soil a slippery, greasy feel when rubbed between the fingers, and the particles exposed to the sun cause the surface to sparkle on a bright day. A more pronounced mica content gives to the subsoil an extremely soapy feel. This characteristic is usually intensified with approach toward the derivative rock, which, in most cases, lies from 2 to 5 feet beneath the surface, and the mass of decomposed mica overlying the rock is generally encountered within 36 inches of the surface.

A local variation of the Chester mica loam on the south slope of Pennypack Creek, about one-half mile north of Walnut Hill, is most interesting. The disintegrated mica schist outcrops there, and the soil and subsoil derived from this rock are both a yellow sand, which if occurring in sufficient areas would have been classed as the Chester sand.

The Chester mica loam has but limited occurrence in this county. The principal area occurs along each side of Pennypack Creek at the extreme eastern end of the county, and there are four scattered areas in the vicinity of Jenkintown.

The type as a whole is moderately rolling in topography, but it includes some small steep slopes, which the agencies of erosion have so depleted of surface covering that the disintegrating rock lies exposed or but a few inches beneath the surface.

Good drainage is secured by the loose and mellow texture of the soil, brought about largely by the mica content. The type does not wash badly, except on a few steep slopes.

The Chester mica loam is derived principally from the Philadelphia and Manayunk schists, but in a few minor instances the Chestnut Hill schists have played some part in the formation of the type.

The Chester mica loam is fairly well adapted to early garden crops and light farming, but its position relative to Philadelphia gives to it a value not at all commensurate with its worth for farming purposes, and consequently its management is such that no accurate estimate of crop yields can be given.

The following table shows the results of mechanical analyses of the fine earth of both soil and subsoil of this type:

Mechanical analyses of Chester mica loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13043	Soil	0.5	1.9	1.3	3.8	3.9	64.3	23.6
13044	Subsoil	.1	1.1	.7	2.1	3.6	64.2	27.6

CECIL CLAY LOAM.

The surface soil of the Cecil clay loam consists of reddish-brown or brownish-red silty clay loam to an average depth of 8 inches. This material is sufficiently heavy and stiff to form troublesome clods if worked when too wet, but with care it is not difficult to maintain a satisfactory physical condition. The subsoil consists of a heavy clay loam or clay, and while seldom a distinct red its reddish color is more pronounced than that of the soil. Igneous stones seldom exceeding 3 inches in diameter occur on small areas to the extent of 15 to 35 per cent, but their presence is never sufficient to interfere materially with cultivation.

The Cecil clay loam is found in Montgomery County only in small and scattered areas, of which the largest lies east of Norristown, in Plymouth Township, while most of the others occur along the intrusive range of hills and ridges which extend west and northwest of Spring Mount.

The topographic features of the type are moderately rolling or hilly, and so surface drainage is always sufficient and sometimes so rapid as to cause washing and slight gullying. The physical character of the subsoil is such, however, as to hold a good reserve supply of moisture and crops seldom suffer from drought.

The Cecil clay loam is derived from the igneous rocks—mostly syenite and trap—of the dike formations. As these rocks disintegrate—especially the former—they break up into small aggregations of mineral particles of the average size of buckshot, and these are often found in considerable amounts in the subsoil, and occasionally the finer particles are mingled with the surface soil, giving to it a very sharp, gritty feel.

The type is capable of producing fair yields of the general farm crops and is best adapted to that purpose. The average crop yields are estimated as follows: Corn, 40 bushels; oats, 25 bushels; wheat, 12 bushels; and hay 1½ tons per acre.

The following table shows the results of mechanical analyses of samples of fine earth of the soil and subsoil of this type:

Mechanical analyses of Cecil clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13644............	Soil.........	0.9	2.8	1.9	3.9	5.0	60.3	25.0
13645............	Subsoil.....	.5	3.1	2.1	4.5	4.1	56.2	29.2

CECIL STONY LOAM.

The surface soil of the Cecil stony loam consists for the most part of reddish-brown clay loam, or heavy loam, to an average depth of 8 inches. The surface soil does not present an even texture, and the lines of demarcation are as a rule very distinct. If the principal parts of a given field, for instance, are a clay loam, there may be occasional spots of a stiff heavy clay, the boundaries of which are very sharply drawn. Such spots are intractable, but although it is difficult to keep them in good physical condition their limited area renders them insignificant. The subsoil of the Cecil stony loam consists of a brownish-red stiff heavy clay which in places contains enough particles of the disintegrating parent rock to make it very gritty. From 30 to 60 per cent of igneous rock fragments are found on the surface, and a similar content is mingled throughout soil and subsoil. These fragments are largely syenite with some trap and granite. Occasional large bowlders are also a feature of this type, particularly along its boundaries with the Rough stony land.

A variation occurs in the small areas in the eastern part of the county where the soil is a light loam containing here and there a small area of heavy fine sandy loam. On steep slopes some large bowlders and ledges are seen, but on more level areas such occurrences are seldom, and the stone content of 40 to 70 per cent consists mostly of angular and flat-sided fragments. The subsoil consists of a heavy loam, grading into a clay loam in some places, but very often the stone content prevents boring below 12 inches.

The principal occurrence of the Cecil stony loam is in the western part of the county, where it extends along a series of ridges and hills from Spring Mount west to Ringing Rocks, and also from Spring

Mount northwest to Perkiomenville, where it divides, one arm extending northeast to the county line and the other nearly to the northwest corner of the county.

The topographic features of the Cecil stony loam are much broken. Level areas of appreciable extent are very rare, whereas steep hillsides are so frequent that the type is difficult and costly to work. Such topography makes surface drainage so rapid that hillsides generally suffer more or less from washing, while the adjoining hollows are kept so wet as to be in a very soggy condition for a considerable period after each rain. In seasons of only moderate rainfall, however, the type maintains a supply of moisture favorable for growing crops.

The Cecil stony loam is derived from intrusive rocks, which also constitute the present stone and rock content of the type.

Owing to the topography and the stony character of the Cecil stony loam most of it is not well adapted to tillage because of the attending expense and trouble, although the soil is moderately productive with good management. It is best adapted to permanent pasturage, with the exception of a few of the most easily tilled fields, upon which the staple farm crops may be profitably grown. On fields with favorable exposure the type is also adapted to the production of apples.

The crops grown, with their average yields, are estimated as follows: Corn, 40 bushels; oats, 20 bushels; wheat, 10 bushels; potatoes, 75 bushels, and hay, 1 ton per acre.

The following table shows the results of mechanical analyses of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Cecil stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13646	Soil	0.3	4.1	2.7	5.6	5.6	54.1	27.4
13647	Subsoil	1.6	5.9	3.5	8.1	7.9	40.6	32.3

ROUGH STONY LAND.

The soil and subsoil of the Rough stony land are so similar to the Cecil stony loam that additional description is unnecessary, but the surface is so covered with stones, bowlders, and rocks as to render it unsuited to any tilled crops. The topography of the type, too, is generally so broken and rough as to accentuate its undesirability for agricultural purposes.

The Rough stony land is located in the western part of the county, where it is found at Spring Mount, Ringing Rocks, and broken areas between those places and north of them, usually associated with the Cecil stony loam.

The type was formed byt he intrusion of igneous rocks as dikes, of which it occupies the roughest parts. The Rough stony land is usually left in forest, for which purpose it is best adapted, though small areas are sometimes included in permanent pastures.

HAGERSTOWN LOAM.

The surface soil of the Hagerstown loam ranges from a heavy brown silt loam to a silty clay loam. The silt content is always high, and where the clay content is sufficient to constitute a clay loam the presence of such large quantities of silt gives to the soil the character of a heavy silt loam, very mellow, and easy to work, notwithstanding the fact that the content of all coarser grades of material, whose presence is in most cases the cause of the mellow characteristic of soils, is exceptionally low. At an average depth of 12 inches the surface soil is underlain by a heavier silt loam or clay loam of a light-brown or yellow color. Where the immediate subsoil has the characteristics of a heavy silty loam, it usually grades into a mellow silty clay loam at depths ranging from 20 to 30 inches, and at greater depths into a silty clay. Even in the latter case, however, the subsoil never becomes stiff and intractable, but remains friable and open. From 5 to 20 per cent of small cherty fragments are found in spots on the surface, and a similar content often occurs in the subsoil.

A variation of small area, much inferior to the normal type in crop value, occurs in the southwest corner of the county near Valley Forge and 1½ miles southwest of Port Kennedy. There, on top of a ridge as it leads out of the county, the soil consists of a silty and fine sandy loam containing enough small stones and fragments to prevent boring, but the extent of this material is insufficient to be mapped by itself.

The Hagerstown loam is located in the southeastern part of the county, where it extends from near Valley Forge through King of Prussia and Plymouth Meeting to within a mile of Willow Grove.

The topographic features of the type are those of a quasi valley, hemmed in by higher metamorphic rock formations. The valley within itself, however, is rolling, and includes many well-rounded limestone hills, and is also marked here and there by steeper hills which jut into it from the adjoining formations of metamorphic rocks and sandstones.

The drainage features of the Hagerstown loam are well defined, and, in general, afford sufficient surface drainage. The texture of the soil and subsoil also subserve a favorable supply of moisture, being neither so open as to allow excessive drainage nor so close as to prevent sufficient percolation.

The Hagerstown loam is derived from the weathering of limestone, which is usually magnesian. From the siliceous impurities are derived the varying amounts of chert present. Along the border of the limestone with the igneous rock formations the former has been metamorphosed into a marble in some instances, and at Marble Hall an excellent quality of marble has been utilized for building purposes.

Formerly large quantities of the impure limestone were quarried and burned, much of the product being used by farmers to apply to the land. The exhaustion of good limestone near the surface caused most of the kilns to be closed several years ago, but a few large ones are still worked.

The Hagerstown loam is well adapted to the production of the general farm crops grown in the area and excellent yields are obtained when the soil is well farmed. In the western part of the area the type is considered worth from $100 to $125 an acre, but very little of it is for sale at this price. The average crop yields are: Shelled corn, 65 bushels; oats, 35 bushels; wheat, 25 bushels, and hay, 1½ tons per acre.

The following table shows the average results of mechanical analyses of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Hagerstown loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12917, 13650	Soil	0.7	2.9	2.4	6.1	6.7	57.6	23.1
12918, 13651	Subsoil	.8	1.9	1.8	4.1	6.0	59.1	26.2

An investigation of the manurial requirements of this soil was made, using a large sample collected 2 miles west of Flourtown, Pa. The soil here is a heavy silty loam, mellow, and easily worked. The sample was taken to a depth of 6 inches. The farm has been in cultivation for over fifty years and the condition of the field is representative of this type of soil for the area, the principal crops being corn, oats, wheat, and grass.

The results obtained indicate that a moderate increase in productiveness can be obtained by the application of cowpeas and lime; that a complete fertilizer consisting of nitrate of soda, sulphate of potash, and acid phosphate with lime will produce a small increase, while an application of stable manure will produce an increase almost as large. The complete fertilizer without lime gives a very slight increase and lime alone has little effect.

In these tests wheat plants were used as an indicator and the results are held to apply alone to the field from which the sample was taken. They are, however, in accord with the practice of the community in placing a high value on cowpeas and manure for fertilizing purposes, and it is believed that with soils in a poorer state of cultivation the results obtained would be more marked.

CONESTOGA LOAM.

The surface soil of the Conestoga loam consists of yellowish-brown loam 12 inches deep. This is underlain by a yellow loam which contains finely divided particles of mica, has a distinctly greasy feeling, and at depths ranging from 28 to 30 inches passes into decomposed limestone schist. The schist is thoroughly decomposed, is very greasy or soapy, and its color is greenish yellow.

The only important area of the Conestoga loam is in the vicinity of Conshohocken, where it extends in a belt about one-half mile in width from near Gulf Mills to Lafayette Hill, a distance of 4 miles. Three other small and unimportant areas are scattered along the Limestone Valley.

The topographic features of the Conestoga loam are somewhat more steeply rolling than those of the adjoining Hagerstown loam and the type includes little level land. Such physiographic conditions bring about thorough surface drainage, which in some cases on the steepest hillsides has been so rapid as to cause injury by washing. The texture of the soil is such as generally to maintain well the available supply of moisture and crops seldom suffer severely from drought.

The Conestoga loam is derived from limestone schist which occurs between the Hagerstown loam formation and the metamorphic rocks south of it, and in this position represents limestone which has been somewhat altered by the processes of metamorphism.

The type is well adapted to general farm crops, but is not quite as productive as the Hagerstown loam. About one-half of the type is included in Conshohocken and its suburbs, and on account of its position so little of the type is farmed to advantage that no estimate of the crop yields is given.

The following table shows the results of mechanical analyses of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Conestoga loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13648	Soil	1.0	3.1	2.7	17.7	18.2	36.9	20.5
13649	Subsoil	.8	2.2	2.0	18.7	17.9	40.1	18.2

DEKALB GRAVELLY LOAM.

The surface soil of the Dekalb gravelly loam consists of a brown loam to heavy sandy loam from 8 to 12 inches deep, containing from 5 to 30 per cent of fine quartz gravel. Traces of coarse gravel are sometimes found, but little exceeds one-eighth inch in diameter and much of it is smaller than that. In some areas this gravel content is sufficient to make quite friable what would otherwise have the properties of a heavy loam. The subsoil consists of yellow light loam, containing from 20 to 60 per cent of gravel and coarse sand, the amount of which steadily increases with depth until a bed of fine gravel is reached at depths ranging from 8 inches on small, sharp hilltops and steep upper slopes to 30 inches on large, nearly level areas or lower slopes.

The principal areas of Dekalb gravelly loam are on each side of the Schuylkill River, one extending northeast from Norristown and the other west from Conshohocken. From the former a series of small, detached areas extends northeast to near the town of Horsham, while from the Conshohoken area another series extends west toward Valley Forge.

The topographic features of the type include a series of small parallel ridges and little hills. Where these elevations are near together, the intervening depressions are occupied by the same type, thus forming a continuous area of considerable size; but where the hills and ridges are some distance apart, they are separated by other types of soil.

Drainage is so well established by the topography of the type and by the presence of the gravel, which tends to keep the subsoil loose, that the Dekalb gravelly loam rarely suffers from excess of moisture, yet in seasons of normal rainfall its storage capacity is sufficient for good crops to mature. In dry seasons, however, crops are soon affected, and only low yields are obtained.

The Dekalb gravelly loam is derived from sandstone conglomerate of the Potsdam age. Large amounts of fine quartz gravel are embedded in the sandstone, and when the bed rock is exposed it weathers rapidly, and as it disintegrates and the finer material is washed away the fine gravel may often be picked up in handfuls. On steep positions where much of the soil has been eroded away the disintegrating bed rock is frequently found at depths of a foot or more, and in such minor instances the soil is unproductive.

The Dekalb gravelly loam is fairly well adapted to the production of general farm crops. Tomatoes and other late garden crops are successfully grown and the location of most of the type is such that it can be used to the best advantage in this way. In the immediate vicinity of Norristown, Conshohocken, and Port Kennedy little farming is done on this soil.

The following table shows the results of mechanical analyses of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Dekalb gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13654............	Soil.........	4.6	24.3	10.6	11.8	10.9	27.1	10.3
13655............	Subsoil.....	5.1	27.7	11.6	10.2	8.0	20.0	17.3

MANOR STONY LOAM.

The surface soil of the Manor stony loam consists of clay loam or a heavy loam, yellow or reddish-brown in color, containing such large amounts of small rock fragments that one can seldom bore more than 6 or 8 inches. The rock fragments are principally mica schist, though lesser amounts of other metamorphic rocks are frequently found.

The subsoil as exposed in road cuts consists usually of a heavy light-brown or slightly grayish loam, a little lighter in texture than the soil, but it is sometimes heavy enough to constitute a clay loam. The subsoil always contains a high per cent of small schist fragments and in places is a little more than a mass of these fragments with the interstitial spaces filled with soil. On the surface there are seldom any rocks or large stones, but near Gulf Mills, at the foot of the steep slope occupied by this type, there are a few spots strewn with bowlders of trap rock. On the high hill east of King of Prussia the soil consists of a light to medium loam and the subsoil is a heavy loam filled with schist fragments. At the extreme top of the same hill the surface is covered with bowlders and fragments of white quartzite.

The principal area of the Manor stony loam lies west of Conshohocken, extending from the Schuylkill River west to the county line. Other scattered areas occur north of the limestone valley, mostly in the township of Whitemarsh.

The topographic features of the Manor stony loam are hilly or mountainous and the slopes for the most part are steep. As a normal concomitant of such topography the surface drainage of the type is always rapid, and unless the rainfall is very slow and gentle it is excessive.

The type is derived primarily from the disintegration and decomposition of mica schists, the influence of other rock formations being relatively unimportant.

A small part only of the Manor stony loam is adapted to cultivation. Where not too steep the type produces fair yields of the staple crops and is considered moderately productive, but most of the type is covered with forest growth which consists chiefly of second-growth chestnut, several kinds of oaks, some hickory, and a dense undergrowth; and forestry is the best use which can be made of all the steep positions within the type.

The following table shows the results of mechanical analyses of samples of fine earth of the soil and subsoil of this type:

Mechanical analyses of Manor stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13047.............	Soil.........	1.7	6.9	3.9	9.3	7.2	37.8	32.5
13048.............	Subsoil.....	5.6	11.5	5.6	15.6	7.2	34.4	19.9

MANOR LOAM.

The surface soil of the Manor loam consists of yellow or brownish-yellow medium loam to an average depth of 8 inches. The subsoil consists of reddish-yellow heavy loam which grades into a clay loam at an average depth of 27 inches. The subsoil usually contains small amounts of minutely divided mica, which give to it a greasy feel when rubbed between the fingers. Mica schist fragments are occasionally found upon the surface and mingled throughout the soil mass to the extent of from 3 to 10 per cent. These fragments are generally from 1 to 2 inches in width and very thin, seldom exceeding a thickness of one-fourth inch, and they break up slowly in the form of scales; a trace of which is often visible, especially in the subsoil.

The Manor loam is located in the southern part of Montgomery County, along the lower slopes of the ridge of Manor stony loam, which extends from near Gulf Mills westward through Upper Merion Township to the Chester County line.

The topographic features of the Manor loam are thus moderate to gentle slopes, and show a tendency to broaden into larger moderately rolling areas as the type enters Chester County, where it seems to be better developed. It is well drained, but not excessively so, as its texture is such as to retain a good supply of moisture for all crops.

The type is derived from mica schist, most of which is dark gray or greenish in color.

The Manor loam is best adapted to the production of the staple crops of the area, and moderate yields are produced, but it is not especially good for any of these crops. Corn averages 50 bushels, wheat 15 bushels, and hay 1¼ tons per acre.

The following table shows the results of mechanical analyses of samples of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Manor loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14400	Soil	3.7	2.8	1.6	9.9	9.1	47.8	24.1
14401	Subsoil	2.7	4.9	1.8	7.2	11.2	46.8	25.3

MEADOW.

The type mapped as Meadow in Montgomery County is very limited in occurrence and includes only narrow areas bordering some of the stream courses. The soil is of variable texture, but is most often clay loam. The low, flat position of the type renders it liable to overflow at least several times during the year, and though in rare seasons a cultivated crop might be grown successfully, the chance is too precarious to be attempted, and such areas are used as pasture. In places stone and shale have been washed over the land and left in the form of undesirable deposit as the waters receded.

AGRICULTURAL METHODS.

There are thirteen types of soil in Montgomery County used for tilled crops, and upon them a wide range of methods of cultivation may be observed, but these methods seem to depend quite as much upon location with reference to Philadelphia as upon differences in the character of the several soil types. Another determining factor in the kind of methods which obtain is the character of the ownership. In the eastern part of the county much of the land is owned by a wealthy class of men, who in the management of their farms are not obliged to consider whether any profit is to be derived from their operations, and consequently the land is seldom managed economically. Occasionally one of these wealthy farmers is thoroughly interested in agriculture, practices the most approved methods, manages his farm upon a most businesslike basis, and by careful and somewhat intensive farming is able to show a profit from his fields at the end of the year, thus demonstrating that it is possible for the land to be profitably farmed when it can be bought for its farming value. More often, however, if any appreciable attempt is made by the owners to farm on these lands, all the manure thought desirable by the manager to apply is brought from Philadelphia by the carload, and the cost is an element almost unconsidered. Such methods bring the land to a very productive state, but often not in a way to be practiced by the average farmer, who must be economical if he would succeed.

The desirability of much of the land for the location of surburban residences, however, has effected a rise in its commercial value far above the prohibitive limit for use as farming land. In this way important areas have fallen into the hands of speculative dealers and real estate developing companies, who then rent it on temporary leases, which seldom run for a longer term than one year, for a cash rent. Land so managed is in a very exhausted condition, which gets worse each year, for complete returns from fertilizer and labor invested can not be obtained in any given year, and hence the tenant can not afford to improve the productivity of the soil. On the other hand, land suited for gardening which lies within easy driving distance to Philadelphia, and can be rented for a term of years, is managed intensively, and kept in a high state of productiveness. It will thus be seen that in the eastern part of the county almost every degree both of intensive and extensive agricultural methods is practiced.

In the central and western parts of the county different conditions obtain, and the area is more distinctly agricultural. The methods of cultivation practiced in this main part of the county are diverse, and on the whole inefficient in that they lack thoroughness of operation. Land is plowed to an average depth of 4 inches, though advocates are found for all depths between 2½ and 8 inches. On the Chester loam, where the yellow subsoil lies nearest the surface, the best results have been obtained by plowing not deeper than 4 inches or 5 inches. Deeper plowing, which has turned up some of the subsoil or the yellowish-brown material which sometimes immediately overlies it, has been found injurious in numerous instances, as it is claimed that even when the amount of such material brought to the surface is small, the crop yields have been in some degree diminished. There is no question, however, that the type should be plowed as deep as possible, even to 8 or 10 inches, without producing this undesirable effect, and this is also true of the other members of the Chester series.

On the Penn silt loam, Lansdale silt loam, and Dekalb shale loam the best results are obtained by those who plow to a depth of 6 or 7 inches, provided that land which has previously been plowed shallow is plowed only a little deeper each year and thoroughly tilled until that depth of seed bed is acquired. In a few instances cross plowing has been successfully practiced as a means of more thorough preparation of the seed bed. Care must be exercised with all the uplands to prevent washing, for if neglected they are susceptible to much injury from that source. In general, plowing is well done, but the preparation of the seed bed following is seldom sufficient. In some parts of the county disk harrows are used, but the spring-tooth harrow is more universal. Most farmers have one or the other of these, but they are rarely used with sufficient thoroughness. During the progress of the survey much corn land was planted under conditions which seemed to indicate that it was deemed ample if the biggest clods on the surface were crushed, and it is very apparent that more thorough preparation of the soil would bring greatly increased yields.

A notable instance may be cited from Lower Merion Township, where methods advocated by this Bureau were put in practice for increasing the productiveness of soils by improving the mechanical condition, whereby increased thoroughness of cultivation has proved the equivalent of more than half of the amount of fertilizer previously applied.

A field of the Chester loam was plowed from 8 to 12 inches deep, according to the local possibilities with reference to depth of surface soil, worked and reworked with the utmost thoroughness in the preparation of the seed bed by the use of cutaway and other harrows, alternating with rollers until the ground was in fine mechanical condition before planting. This was followed by numerous cultivations throughout the season. At the same time the application of commercial fertilizers was decreased from 500 pounds to 200 pounds per acre, and still there has been no decrease in yields at the close of the third year's record of the present season when compared with those obtained by the earlier methods and the heavier application of fertilizer. Such results indicate in a very positive way how the same crop yields may be obtained at less cost or, in other words, how the expense of producing a given crop may be decreased without diminishing the yield or exhausting the land.

The methods employed to maintain the productivity of the soil vary in different parts of the county, but depend largely upon local environment. Within driving distance of Philadelphia specialized farming is practiced to a considerable degree. There little stock is kept and large amounts of manure are hauled from the city stables. Outside the zone in which distance makes this practice profitable manure is brought in carload lots, but this method is far less satisfactory than hauling by teams, not only from the fact that the cost of freight greatly increases the total expense, but also because the quality of the manure so delivered is liable to be much inferior to that bought and loaded under personal supervision. With increasing distance from Philadelphia much more stock is kept and correspondingly less manure is bought. In the eastern part of the county commercial fertilizers are extensively used in conjunction with stable manure; in the central part such use is general, while in the western part of the county they are used by perhaps not more than one farmer in five. The amounts applied generally range from 200 to 700 pounds per acre, though a larger application is made on occasional farms. Formerly the practice of applying lime to each field about once in the course of a five-year rotation was almost universal. The location of limestone quarries within the county made this an economical process. These quarries have been largely exhausted, and although the best farmers still purchase lime many others, and most all of the large number of renters, feel that direct returns in one year do not equal the cost and so have discontinued its use.

The customary method of saving and applying manure is inordinately wasteful, particularly in the western half of the county. In many sections the topography is broken by many little steep-sided hills and valleys, and the barns are so located with regard to slope of ground surface that all drainage from the barnyard rushes down hill to the nearest branch and is speedily removed from the precincts of the farm. Even where the yards are inclosed by neat and substantial walls made tight with mortar drainage channels are carefully constructed at the base of the wall to allow all drainage to rush down an adjoining public road or chance depression. In addition it is a frequent custom to throw all manure as fast as made out from under cover into the open yard, where the rain and drippings from the eaves wash through it and still further remove to waste the most valuable elements. The loss entailed by this process is prodigious, and it seems exceedingly strange that it should be allowed for a moment by a class of farmers who are exceptionally economical in most of their practices, for they are most extravagant in this respect. The most common method of application discloses, too, the failure to realize as much direct benefit to crops as could just as well be obtained from the same dressing by the observance of a little more care in performing the work. Manure is generally thrown from the wagon into small heaps, from which a second man carelessly spreads it by hand, seldom exercising sufficient care to break up the large pieces. In this way many spots are manured to expensive excess, while others receive comparatively little benefit. The same amount of labor could spread the manure with much more uniformity and effectiveness directly from the wagon, while a good mechanical spreader would save its cost many times.

The loss brought about as above enumerated by the failure to conserve and utilize to the best advantage the manurial products of the farms undoubtedly represents the most flagrant general case of poor management in the entire area, for otherwise the farmers and their families work hard and manage so economically that in spite of such waste at least a comfortable living is obtained. Tilled crops are generally well cared for and kept nearly free from noxious weeds, but unfortunately occasional fields are allowed to become overrun with them and the seeds are scattered far and wide.

The farm equipment on the average is fairly complete. The supply of machinery and tools, while deficient on some farms, is generally from moderate to ample. Plows, harrows, mowing machines, hay rakes, and farm wagons are, as a rule, good. Grain drills are of and between both extremes. Many drills of early pattern, which have lasted a long time, because they have not been used on a large number of acres in any one year and have been carefully housed, are still in use, and though far out of date do satisfactory work on the scale required of them. The same may be said of reapers, many of which do not bind the grain. Hay tedders should be in much more general use, not only for the economy of labor, but more especially for making it possible to get the hay into the barn in much better condition. Horse forks for unloading hay are in general use in some parts of the county, and field hay loaders are frequently seen in the most level districts.

The common system of crop rotation practiced consists of corn, oats, wheat, and grass. For these crops the usual practice is to apply a dressing of manure for corn, and another after the oats are harvested the following year for the succeeding wheat crop. In addition, commercial fertilizer is usually applied for wheat, and somewhat less frequently for corn. After seeding hay is harvested for two or three years, but the dressing of manure previously applied has seldom been sufficiently heavy to produce a good crop of hay for that length of time, and the last one or two cuttings is not only small in quantity but also poor in quality on account of the weeds present. In some cases the fields are pastured during the last year of this rotation. Some change in this method of rotation is effected by substituting rye during the third year for part of the wheat, and oats have proved so unsatisfactory in some districts on account of rust and blight as to be omitted from the rotation. Corn is then sometimes grown for two years in succession. Those who have silos occasionally drill with wheat as soon as possible after harvesting the ensilage corn. In the eastern part of the county a rotation often used is corn, oats and potatoes, wheat or rye, and grass.

AGRICULTURAL CONDITIONS.

The financial condition of the farmers of Montgomery County exhibits a considerable diversity in the degree of prosperity attained, and, if studied from the view point of cause and effect, reveals in a very definite way certain periods of agricultural development, while from another standpoint the widely varying conditions included in the county to-day show at a glance almost every stage of agricultural development and its attendant degree of prosperity. In the western two-thirds of the county methods are still extensive and have not been intensified as the location with reference to the excellent markets of Philadelphia warrants. Many of the farmers in that part of the county are still trying to compete with the West in the production of grain, which can be grown more cheaply there because of cheaper lands, the possibility of handling the crops during the processes of cultivation and harvesting more economically, and the fact that the freight rates are not proportionally high. In the eastern part of the county the methods of farming are more intensive in some sections. The nearness to Philadelphia tends toward greater specialization in crop production, and those who have recognized the opportunities presented by the excellent markets are not only prosperous themselves, but have set an example in kind if not in degree to the rest of the county.

The general appearance of Montgomery County, however, is not a true indication of the prosperity of the farming class, and this is especially applicable to the eastern part. Proximity to Philadelphia renders that part of the area particularly desirable for suburban residences, and so popular have certain sections become that land is worth several thousand dollars an acre, and considerable tracts are held at from $500 to $1,500 an acre. Such lands are owned by wealthy men who have usually erected costly residences, or by real estate dealers who hold or develop them as a speculation.

The greater part of the county, however, removed from suburban environment, is distinctly agricultural. Formerly the farming class was generally prosperous and the great number of excellent farm dwellings and barns of the present day was made possible by the money made during that period. Then many became well to do, and Montgomery ranked as one of the leading counties of the State in value of agricultural products. Two or three decades ago, however, competition with the West grew so keen, as far as the production of the staple farm crops was concerned, that it become very difficult to make any money. Only by hard work and constant economy could both ends be made to meet, and as a result the price of farms grew less and less. A continuance of such conditions had a depressing effect in two ways. Some offered their farms for sale at a sacrifice, while more retrenched their expenses and endeavored to live within the income derived from the farming methods to which they had always been accustomed. The majority of farmers were thus able to meet all expenses but could get little ahead, and agriculture seemed in a stationary stage for some time. The problem of profitable agricultural production was solved again when a few of the most comprehensive farmers so changed their methods as to supply the near-by markets with perishable products in which there was less competition, and thus developed a new system which proved profitable. At present the feeling is general among the most stable farmers that they receive little or no return for the capital invested, and a more crucial example of conditions is the fact that few young men without much capital feel that it is possible for them to buy a farm subject to encumbrance with a probability of owning the property free from debt in the course of time. This fact not only prevents many young men from assuming the responsibilities of farming, but also causes many sons of well-to-do farmers to leave the farm. Notwithstanding these discouraging features earnest young men do overcome them, and by competent management, hard work, and thrift, attain comfortable circumstances. The most vital element necessary for successful farming in the area at the present time is to study how to avoid competition in the production of staple crops which can be grown more economically elsewhere, and to produce more highly specialized and perishable products to supply the large markets which are close at hand. Under such management a young man can run in debt for a farm to three-fourths of its value and within a reasonable time remove the encumbrance if he will be economical, use good judgment, and work.

Farm tenure is so variable in different parts of the county, and even in certain local sections, that any estimate of the county as a whole, even if exact, would be meaningless. In the extreme eastern part of the county very few landowners till their own land or take any active part in its management, though they may occupy the residence thereon. In such cases a farm manager directs all farming operations. Much of the land which has not been improved for residential purposes is rented out by real estate agencies or speculators for a stated cash rent. Such leases are unpopular and unremunerative to both parties, because the lessor reserves the right to cut new streets through the property at any time, and so the tenant can not afford either to pay much rent or to improve the condition of the soil.

In the central and western parts of the county probably three-fourths of the owners live on and till their farms. In local sections 90 per cent of the farms are worked by their owners, but in other sections not more than 60 per cent are so managed, and there is a general tendency to increase the number of rented farms. Scattered over the county are many farms owned by city residents, who paid more for the property than it was considered worth for agricultural purposes. Many such owners tire of their country property, and then as they are unable to sell it for as much as they paid, hold it and simply cut the hay, while the land and the buildings both get in a bad condition. For the rented farms some are leased for a stated cash sum and others for a share of the products. Under the latter system by the most common arrangement the owner of the farm furnishes one-half the seed, sometimes one-half the fertilizer, and occasionally part of the stock. The tenant does all the work, furnishes one-half the seed, one-half or more of the fertilizer, and receives one-half of all crops. In addition the stipulation is usually made that the tenant must have enough stock to consume his half of the hay on the farm. If the hay is sold the proceeds are equally divided.

Most of the farms range in size from 30 to 100 acres, but a few contain as much as 150 acres, while in the eastern part of the county and around the large towns and villages the land is divided into much smaller tracts.

The supply of labor was plentiful and its character efficient until within the last few years, when it has been growing more scarce, and as a result somewhat less competent, if considered as an entirety. The price of labor for men ranges from $16 to $30 per month with board. Formerly farm hands were commonly hired for a period of eight months, but the difficulty of obtaining men for this length of time is increasing, as many will not enter a contract for a shorter period than one year and then often wish to keep a driving horse, which in some instances is to be used enough on the farm to pay for its keeping. Much of the labor is hired by the day, and the price ranges from $1 to $1.25 a day with board, or $1.50 a day without board, except in harvest season, when the above rates are often increased to the extent of 50 cents a day.

The whole labor problem, however, is somewhat local in its aspect, and it is necessary to hire much less farm labor than the amount of the agricultural products would lead one unacquainted with the conditions to expect. This is because the women and girls, particularly in the northern and western parts of the county, do so much work, not only about the barns in caring for stock and milking, but also in the fields, that the amount of farm labor performed by a man and his family may be very large.

In many of the villages, both large and small, are located cigar factories, which get their labor from the immediate vicinity. Thus are employed in the aggregate large numbers of young men and women who feel that they can get money easier in that way than from farming or by working for wages on the farm, and as many of them come directly from farms this tendency bears much import as to who are to work the farms in succeeding generations. The cigar factories are only one of various pursuits which are drawing young people away from agriculture, but they illustrate a growing tendency which can not fail to show in time a marked effect upon the agricultural development of the county.

The character of the principal products is diversified. Wheat has been the leading money crop with the majority of farmers for a long time. In quality it is all No. 2 and No. 3. Of the other cereal crops, oats and rye are grown in large amounts, and a little buckwheat is produced. Large quantities of hay are sold, and with many farmers it is the principal money crop. Dairy products have always held an important position, and in 1880 the county ranked second in the State in value for this product. Large quantities of milk are shipped to Philadelphia, some is retailed in villages and in the city, and local proprietary creameries consume a great deal. Some of these creameries were formerly run on a cooperative basis, but as this plan did not prove satisfactory they were sold. The milk is now bought by the creameries, which use the Babcock test to ascertain the amount of butter fat present. Some of the skimmed milk is bought back by the patrons to feed to pigs and calves, and in some cases it is sold to manufacturers of casein products. Some farmers sell a part of their corn, but most of it not used for dairy cows is fed to steers and hogs, which are an important product on many and the chief product on a few farms. Of the steers fattened, some are raised at home, but more are bought at an average age of 2 years and stall fed. A considerable part of the corn crop is put into silos, most of which are of the round form and well constructed. For this purpose large varieties are grown.

In the eastern part of the county, where the Philadelphia markets are of easy access, much attention is given to late garden crops, of which tomatoes and sweet corn are the most important, but asparagus, rhubarb, cabbage, small fruits, and several other minor crops are also grown. Throughout the county poultry is an important adjunct of the farm, and in many cases it is one of the leading money products. The markets for poultry and eggs are excellent, and the relative importance of this industry is steadily increasing.

Very little attention is given in general to the adaptation of the different soil types to crops, and on lands used for general farming corn, oats, wheat, and grass are grown on all soils alike. Most of the soils are heavy in texture, and so not adapted to early garden crops. The Chester fine sandy loam is an exception in so far as texture is concerned, but the broken surface features of most of the type and the high price of much of it because of its desirability for residential purposes precludes the possibility of its use for this purpose to any great extent. It is generally recognized that Lansdale silt loam is better for potatoes than Penn silt loam and also for wheat in that it produces a little harder grain. The Dekalb shale loam is also chosen for potatoes on farms which do not include the Lansdale silt loam.

The transportation facilities of the area are good. Main lines of the Pennsylvania Railroad and the Philadelphia and Reading Railway cross the county, and the numerous branches of these lines form a network which leaves no part of the area very far from a railway station. In addition numerous lines of electric railways connect the eastern and central parts of the county with Philadelphia, and one line extends to Pottstown, near the southwestern corner of the county. The highway mileage is enormous and includes many grades of roadbed. Toll is collected on most of the main pikes and on some of the minor roads. In Lower Merion Township, which is used largely for residential purposes, magnificent macadam pikes have been constructed, and many of the important roads throughout the eastern part of the county have been macadamized.

Little more could be desired in the way of markets for farm produce. The excellent and extensive Philadelphia markets are within feasible driving distance of part of the county, and the towns of Norristown, Pottstown, Ardmore, Bryn Mawr, Haverford, Ambler, Lansdale, and numerous others afford good local markets for produce, and flour mills scattered over the county handle the wheat.

SOIL SURVEY OF CHESTER COUNTY, PENNSYLVANIA.

By HENRY J. WILDER, THOMAS A. CAINE, W. J. GEIB, and WILLIAM T. CARTER, Jr.

LOCATION AND BOUNDARIES OF THE AREA.

Chester County is situated in the southeast part of Pennsylvania, and is bounded on the northeast, north, northwest, and west by the counties of Delaware, Montgomery, Berks, and Lancaster, of the same State; on the south by Cecil County, Md., and on the southeast by Newcastle County, Del.

The county includes an area of 486,214 acres or approximately 760 square miles, and is irregular in shape, its width being about two-thirds its length, with the longest median line extending northeast-southwest.

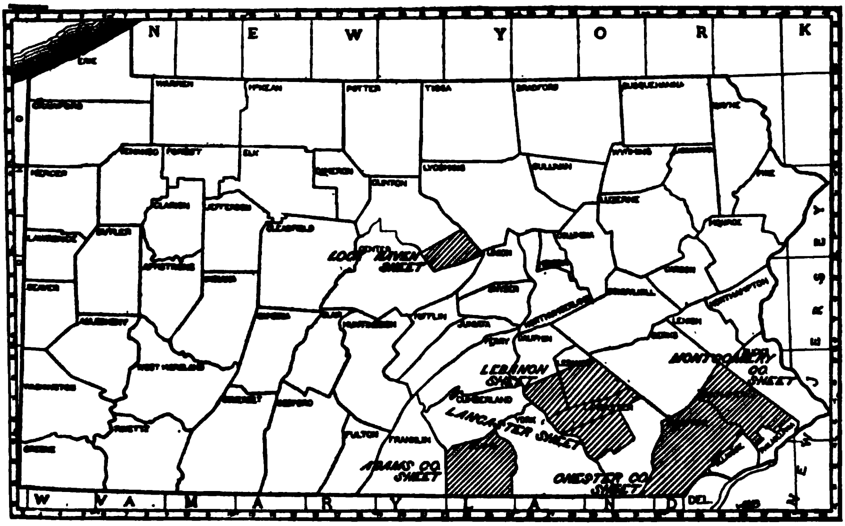

FIG. 4.—Sketch map showing location of the Chester County area, Pennsylvania.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Chester County is said to have been laid off by William Penn in 1682, a year after he had obtained from the King his patent to the territory. Owing to the broad policy pursued by Penn in welcoming settlers of all nationalities and creeds, with the promise of freedom to believe as they chose, the settlement of the section took place with comparative rapidity. English, Germans, Swedes, Welsh, Scotch, and Irish all settled within the confines of the county, and conditions of government and religious freedom were made so broad by Penn that the tranquil and prosperous early development of the county was steady and strong.

The location of the county seat on the extreme edge of the county at Chester finally led to so much dissatisfaction as to cause its removal to near the center of the county at Westchester in 1786.

The practice of agriculture grew apace. Indian corn was found under cultivation by Indians. Wheat was introduced by the first settlers, and barley, oats, and rye were early cultivated. The Mediterranean wheat was introduced about the year 1838. Barley continued to be cultivated for a long time, as it was used in the brewing of malt, and was sold readily to the Philadelphia brewers. About 1822 the farmers of Chester and Delaware counties, under the impression that the brewers were combined to keep the price of barley at a low figure, organized the Farmers' Brewery Company and erected a brewery in Philadelphia. This was not a successful venture, and the growing of barley gradually declined and after 1840 very little was produced. Buckwheat and flax were also generally grown during the last century. Clover was early introduced from Lancaster County, but the practice of sowing it did not become universal until about 1825.

Efforts for the improvement of farm stock were begun early. About 1818 some grade Durham cattle were brought from Kentucky, and in 1839 a small importation from England was made. The Spanish Merino sheep were introduced soon after 1810. By fortunate crossing of blood and careful management this county has produced a breed of hogs known far and wide as the Chester Whites.

In the early settlement of the county, when fences were scarce and only the cultivated ground was inclosed, all kinds of stock were allowed to run at large, and each farmer identified his own by branding. By the range system, with scanty forage at times, the animals became stunted, and by promiscuous interbreeding the stock degenerated in quality. With the development of the county all stock was inclosed and a systematic improvement of breeds followed.

In 1784 the number of farms in Chester County was 3,558; horses, 8,020; cattle, 10,107; and sheep, 11,896.

Philadelphia has always been the principal market for the dairy products of Chester County. In early days butter, eggs, and poultry were taken thither often by women, on horseback, in butter pails suspended at the horses' sides. Peddlers gathered the surplus provisions of those who did not wish to attend market in person. As the demand increased farmers from the eastern townships drove their wagons to the city loaded with produce for the weekly markets.

When the county was first settled the forests were far from dense, because the Indians had kept the timber from growing by setting fires on the high ground to destroy the undergrowth, thereby facilitating the pursuit of deer, and on the low ground and valleys to enable them to hunt the buffalo. After the departure of the Indians the growth of timber was rapid, and about the period of the Revolutionary war the forests were dense. These were gradually reduced in extent.

Orchards were planted extensively at an early date, and apples especially were abundant. There were also many peaches. Distilleries were erected in many places by which apples and peaches were converted into brandy. But the peach has almost disappeared, as well as plums and cherries, and apple trees have become less productive.

Rye and corn were the principal crops, though some flax was generally cultivated. The corn was planted in rows which ran in one direction, usually north and south, and about 6 feet apart. It was "topped and bladed," and rye was sown between the rows. Even fifty years ago but little wheat was grown, and "coffee" made of rye was in common use. Buckwheat was raised in small quantities. In winter farmers depended on the stripped blades of corn for feed for horses, and on hay obtained from the meadows for cattle and sheep. After the introduction of clover and timothy and the necessity which arose of preparing the ground for the use of the scythe the old method of planting was abandoned, the corn being cut off and entirely removed before the sowing of the winter grain.

Few oats were grown until after the construction of Horseshoe Pike, when the larger number of teams passing along that road with goods for the West made a market for this grain at the taverns along that highway.

It is only since 1835 that the present rotation of crops—corn, oats, wheat, and grass—has been followed.[a]

CLIMATE.

Chester County is far enough north for the ground to freeze solidly in the winter, and yet it escapes much of the rigor of climate found nearer the Canadian line. The ground thaws sufficiently early in the spring and freezes late enough in the fall to insure a growing season of good length, which, with a well-sustained supply of moisture, is very favorable for crop production.

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[a] The historical facts included in this chapter were taken principally from History of Chester County, by Futhey and Cope.

The following table shows the normal monthly and annual temperature and precipitation of the county as observed at the Weather Bureau stations of Coatesville and Kennett Square:

Normal monthly and annual temperature and precipitation.

Month.	Coatesville.		Kennett Square.		Month.	Coatesville.		Kennett Square.	
	Temperature.	Precipitation.	Temperature.	Precipitation		Temperature.	Precipitation.	Temperature.	Precipitation.
	°*F.*	*In.*	°*F.*	*In.*		°*F.*	*In.*	°*F.*	*In.*
January	30.2	3.80	30.6	3.74	August	72.9	4.05	72.6	4.80
February	30.1	4.81	30.7	4.79	September	65.9	4.92	66.1	4.95
March	37.9	4.81	39.0	4.46	October	53.0	3.52	53.9	3.47
April	50.2	3.56	49.4	3.60	November	43.0	3.81	43.4	3.71
May	61.1	4.95	60.8	4.66	December	33.6	3.98	34.0	3.63
June	70.5	3.26	70.0	3.47	Year	51.9	50.73	52.1	50.08
July	74.4	5.26	74.3	4.80					

In the following table are given the dates of the first and last killing frosts in the fall and spring and also the average dates for the period between 1898 and 1904:

Dates of first and last killing frosts.

Year.	Coatesville.		Kennett Square.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1898	Apr. 9	Oct. 27	Apr. 28	Oct. 28
1899	Apr. 17	Oct. 2	Apr. 11	Oct. 2
1900	May 11	Oct. 20	Apr. 15	Oct. 20
1901	Apr. 12	Sept. 26	....	Oct. 19
1902	Apr. 10	Oct. 22	May 29	Oct. 22
1903	May 2	Oct. 29	May 2	Oct. 27
1904	Apr. 4	Sept. 22	Apr. 4	Oct. 8
Average	Apr. 18	Oct. 13	Apr. 25	Oct. 18

PHYSIOGRAPHY AND GEOLOGY.

Chester County is a part of the large physiographic province known as the Piedmont Plateau, with the exception of about 1 mile of the extreme southeast point, which belongs to the Atlantic Coastal Plain.

Geologically the county is composed of metamorphic, sedimentary, and igneous intrusive rocks of Archean, Paleozoic, and Mesozoic ages.

Physiographically the county is best characterized as diversified uplands, to distinguish it from the undiversified lowlands found to the eastward along the Atlantic coast. These uplands are covered by a thick mantle of soil and, as a whole, are nearly free from stones, but along steep-sided stream courses and on the tops and upper slopes of the highest hills areas of a stony loam and of Rough stony land are found associated with six of the seven soil series represented in the county.

The most conspicuous topographic feature of the area is a straight valley (Chester Valley) which extends northeast and southwest across the middle of the county, with a width varying from less than 1 mile at the Lancaster County line to a width of about 2 miles at the Schuylkill River. This valley is occupied by heavily bedded Paleozoic crystalline limestone, which has determined the form of the valley. Hills, usually abrupt and ranging from 100 to 200 feet in elevation, fringe both sides of the valley throughout its length, and from the tops of these hills the country extends as diversified uplands. The floor of the valley itself is not level, but varies from nearly level to moderately rolling and in minor places hilly. The valley does not serve as a principal avenue of drainage for any stream. The drainage of the area is to the southeast, and Chester Valley is cut at right angles by such other steep-sided narrow valleys as those in which flow East and West Brandywine and Octoraro creeks. These larger streams have formed courses which are independent of the structure and character of the rock floor, but the smaller tributary streams are more or less adjusted to the underlying rock formations. From the bottoms of the larger streams to the tops of the hills the difference in elevation varies from 100 to 250 feet, while from the bottoms of the smaller tributary streams to the tops of the near-by hills the difference in elevation varies from almost nothing to about 100 feet.

The altitude of the lowest point in the area, which lies within the narrow southern extension of the county between Maryland and Delaware, is 100 feet, and the highest point is 940 feet, thus including a range in altitude of 840 feet. If the comparatively slight depressions made by all of the present streams were filled in, a nearly level plain sloping gradually seaward would result.

The diversification of the uplands, however, caused by the carving of very irregular channels by stream courses and the subsequent wearing-down agencies of weathering and erosion, has given to the country both north and south of the Chester Valley a most varied and picturesque landscape. In the southeastern part of the county, and best developed around and northeast of Westchester, is a broad, gentle to moderately rolling area, of which the contours are seldom sharp; the elevations are low and well rounded, and the topography may be characterized as smoothly rolling. This area, though not as well defined as the limestone valley, is, in a general way, parallel to it, and toward its northern part ascends at first gradually and then more steeply to the top of the ridge, which then slopes abruptly to the limestone valley. Southwest from this area, beginning with the east bluff of the Brandywine and extending through Kennett Square and Strickersville to the Maryland line, and thence north to the Chester Valley, the land surface is not so smooth in contour, for the elevations are often steep sided and the stream courses more deeply cut, thus giving more pronounced topographic features. Gently rolling areas of variable size grade into moderately rolling surroundings, which in turn give way to the steep slopes and broken areas along the major stream courses.

Descending slightly from the ridge of Potsdam sandstone and quartzite which borders the Chester Valley on the north is a broad area of uplands similar in topography to those south of the valley, and, with the exception of the slates, derived from the same character of crystalline and semicrystalline rocks, gneiss, schists, and trap. Along a line north from Caln Township to French Creek the topography is so broken, irregular, and steep that the accumulation of soil has been insufficient to cover the derivative rocks, and large areas of stony loams occur. The topography is also much broken along the northern border of this formation where it descends in the northeast part of the county to the general level of the Mesozoic sandstone and shale which in a belt from 2 to 6 miles wide extends to the Schuylkill River. This sandstone formation slopes gradually back from the river in some places and again forms precipitous bluffs, but in general its surface is gently or moderately rolling and marked here and there by a prominent rounded hill or ridge. With increased distance from the river the formation becomes more steeply rolling and makes, as a whole, a steady ascent until it meets the metamorphic rock formations to the southward. The only rough areas associated with the Mesozoic sandstone lie near its western terminus north of the falls of French Creek.

The several geological formations have been and are still in numerous instances of economic importance to the farmers. Large quantities of lime were formerly burned and applied to the land. This has been discontinued for the most part, but refined lime products are still produced on an extensive scale at one plant. Quarries yielding a good grade of marble are also located along the border of the limestone valley. From the serpentine formations green building stone has been extensively quarried and used in the construction of excellent dwellings in some localities, while the Mesozoic sandstone formation along the Schuylkill River furnishes large quantities of red stone for building or masonry purposes.

SOILS.

In Chester County twenty-two soil types were recognized, which are shown by different colors on the soil map accompanying this report. The actual and relative extent of each type is given in the following table:

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Chester loam	202,368	41.6	Lansdale silt loam	5,248	1.1
Manor loam	75,840	15.6	Conowingo clay	4,160	.9
Manor stony loam	33,408	6.8	Penn stony loam	3,520	.7
Penn loam	28,672	5.9	Conowingo barrens	2,944	.6
Brandywine loam	24,000	4.9	Chester fine sandy loam	1,472	.3
Chester stony loam	20,864	4.3	Dekalb shale loam	1,408	.3
Meadow	20,480	4.2	Cecil clay	1,088	.2
Hagerstown loam	19,456	4.0	Lickdale clay loam	832	.1
Dekalb stony loam	14,528	3.0	Portsmouth silt loam	512	.1
Dekalb loam	11,456	2.4	Norfolk silt loam	6	.0
Rough stony land	8,320	1.7			
Dekalb fine sandy loam	5,632	1.2	Total	486,214	....

CHESTER LOAM.

The surface soil of the Chester loam to an average depth of 10 inches consists of mellow, medium brown loam, containing enough medium and occasionally coarse sand to make it feel somewhat coarse in texture. The subsoil to a depth of 36 inches most often consists of brownish-yellow gritty loam, which in the northern part of the county is frequently replaced at an average depth of 24 inches by a gritty light clay loam, and in an area northwest of Parkesburg by a red clay, while in the southwestern part of the area it grades in places into a clayey loam, thus approaching in texture the subsoil of the Brandywine loam, which is most extensively developed in that section.

In the central part of the county, extending in a general northeast-southwest direction, occurs a large area of an important phase of the Chester loam. The surface soil consists of mellow brown silty loam or silt loam from 10 to 16 inches deep. The texture of this material is exceptionally smooth, there seldom being any noticeable content of particles as coarse as medium sand, and yet the related amount of clay is not high enough to give the soil the character of a clay loam. So smooth and plastic is this subsoil that it feels like butter, and the cut of the auger leaves the soil as even and perfect as if done with a sharp knife. This character of material usually extends to a depth of many feet. The silt content, while often insufficient to constitute a true silt loam, is a dominant characteristic of both soil and subsoil. In yields of corn, grass, and spring rye this phase exceeds the typical Chester loam by 20 to 33 per cent.

Where the metamorphic rock formation narrows to a width of about 2 miles between Phœnixville and the Chester Valley the Chester loam includes a phase which well illustrates the manner of its formation. This section is hilly, and the slopes are sufficiently pronounced to be somewhat seriously affected by washing, and the soil has thus not accumulated to as great depth as with the true type and represents a less advanced stage of soil formation. Both soil and subsoil contain large amounts of grit, consisting of angular fine fragments of metamorphic rocks, principally gneiss. These fragments range in size similar to fine and coarse gravel, but are rarely ever sufficiently rounded to be classed as gravel. Such material in a more advanced stage of disintegration is the source of the fine gritty particles occurring in parts of the Chester loam subsoil and occasionally in the surface soil, and remain in sharp contrast to the smooth-textured phase of this type in the central part of the county above mentioned.

Aside from the important area in the central part of the county already described, the Chester loam occurs extensively both north and south of the Chester Valley. From Westchester southeast to Parkersville, Unionville, Kennett Square, and Westgrove, and thence to the Delaware line, it is the most important type, and it is also well developed in West Marlboro and Easttown townships. To the north of the Chester Valley the Chester loam is the principal soil type. It extends north to French Creek and the Welsh Mountain, or nearly to the boundary line between Chester and Berks counties, east to a line through Hallman and West Pikeland, and west to the Chester-Lancaster county line. The continuity of this extensive soil type is broken in certain sections of the county by frequent small areas of Cecil stony loam.

The topographic features of the Chester loam include a wide range. In the central part of the county the type comprises rolling valley land which often includes well-rounded broad hills with gentle slopes. These may be from 100 feet to 150 feet above the general level of the valley, but are not sharp in slope. In the large area southwest from Westchester and in the vicinity of Honeybrook, and extending east as far as Glenmore and north to Warwick, the surface is moderately rolling. An irregular area, including Wallace, Milford Mills, Lionville, Eagle, and West Marlboro Township and local areas south from Westgrove, may be classed as steeply rolling, while the area embracing Chester Springs, Nantmeal village, East Nantmeal village, and St. Peters is hilly. In this rough section there are numerous areas of Cecil stony loam, and the Chester loam itself is sometimes found to have stones and bowlders upon the surface, though not in sufficient amounts to interfere materially with cultivation or to warrant mapping it as stony loam.

Good surface drainage obtains on the Chester loam except in low positions, where it is sometimes so defective as to require artificial drains if the soil is to be cultivated to advantage. In many instances these have been supplied, but in others such areas are used as pasture. These low-lying areas are never too wet to afford excellent pasturage, but, on the other hand, most of them could be drained sufficiently at small expense to convert them into very profitable fields for corn and grass. The texture of the soil and subsoil, moreover, is such as to maintain a favorable supply of moisture, and crops seldom suffer from drought. Such conditions of drainage render this soil exceptionally safe from the effects of untoward seasons, and if efficiently farmed at least a moderate crop is assured every season.

The Chester loam is derived principally from gneisses, but also to some extent from mica schists in which the amount of mica present is much less and more finely divided than in the mica schist from which comes the Manor series and the Brandywine loam.

Chester loam is well adapted to general farming, and corn, oats, wheat, and grass are successfully grown. For the cereal grains it is the best type in the area derived from metamorphic rocks. On the steep hillsides, where there is a large amount of gritty material in the subsoil, and in the areas where the type approaches the Brandywine loam the yields are somewhat lower than where the topography is not so broken.

The average crop yields for Chester loam are, shelled corn, 65 bushels; oats, 40 bushels; wheat, 23 bushels; potatoes, 140 bushels, and hay 1½ tons per acre.

The following table shows the average results of mechanical analyses of samples of fine earth of soil and subsoil of this type:

Mechanical analyses of Chester loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13683, 13685, 14317, 14325, 14327.	Soil.........	3.3	7.5	3.3	8.9	9.3	48.2	19.3
13684, 13686, 14318, 14326, 14328.	Subsoil.....	2.8	6.7	3.1	7.7	6.8	49.3	23.3

BRANDYWINE LOAM.

The surface soil of the Brandywine loam consists of brown loam from 8 to 10 inches deep, in which the relatively high content of fine sand, the presence of a little finely divided mica, and more or less sharp, gritty material, consisting of the small unweathered fragments of the derivative rock, are sufficient to give the effect of a light loam, or in some cases of a heavy fine sandy loam. The subsoil to a depth of 36 inches consists of light-brown to yellowish light loam to heavy fine sandy loam, usually somewhat greasy from finely divided mica. In some sections the mica particles increase in quantity with the depth and become a pronounced feature below 24 inches. The size of these particles also commonly increases with depth until the lower subsoil becomes "flaky," and at a depth of about 36 inches the soil mass consists principally of small mica flakes and small rock fragments. The subsoil sometimes contains a considerable quantity of the small unweathered rock fragments, which give it the texture of a micaceous sandy loam. This phase is most common in the vicinity of Marshallton. A characteristic feature of this type is that the subsoil is always lighter in texture than the soil.

The Brandywine loam is located in the southern, southwestern, and central parts of the county. The largest areas are found in the vicinity of Marshallton, Oxford, and near Lewisville, along the Pennsylvania-Maryland line.

The topographic features of the Brandywine loam are irregularly rolling and hilly. The slopes are steep to moderate, and practically none of the type occupies a gently rolling position. The valley walls of the creek bottoms in the southern part of the county consist largely of this type and are quite steep and in many cases somewhat serrated.

The Brandywine loam has excellent drainage—in fact, it is much too well drained; for the topographic features admit a rapid flow of the surface water, while the loose texture of the subsoil allows a rapid downward flow of soil water. For this reason fertilizers are not retained for a long period, but are soon dissipated by the rapidly flowing surface water or washed down through the porous subsoil by the soil water.

Some areas of the type are so steep that the soil is eroded quite badly and cultivation is very unprofitable. Such areas are most commonly kept in pasture or forest growth.

The Brandywine loam is residual in origin, being formed in situ by the weathering of the underlying mica gneiss, pegmatite, or sometimes mica schist. Where the soil is derived from a mica gneiss the texture is inclined to be gritty on account of the unweathered small, irregular fragments in the soil and subsoil. The rocks from which the soil is derived weather quite rapidly, as is evidenced by the numerous small creek valleys throughout the type.

The natural forest growth of the Brandywine loam consists of chestnut, hickory, and some oak. The type is generally cultivated, although some of the steeper slopes are left as pasture or woodland.

The soil is adapted to no special crops, but is used for general farming, for which purpose it is only moderately productive. It responds readily to fertilizers or to barnyard manure, but their effect is not very lasting, as the soil is porous and so does not hold fertilizers well. Frequent applications of small amounts of commercial fertilizers or stable manure would prove more beneficial and economical than large applications less frequently. The type is locally termed a "quick" or "hungry" land, and owing to its thin character and somewhat steep topographic feature has to be cultivated very carefully to obtain the best results.

The type is used as pasture to some extent and is fairly good for this purpose. Under average conditions corn yields 40 bushels, oats 30 bushels, wheat 17 bushels, hay 1 ton, and potatoes 110 bushels per acre.

The following table shows the average results of mechanical analyses of samples of fine earth of the soil and subsoil of this type:

Mechanical analyses of Brandywine loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14309, 14311	Soil	2.5	5.7	3.1	12.0	13.1	42.7	20.8
14310, 14312	Subsoil	2.9	8.5	4.1	19.9	13.3	33.1	18.1

CHESTER STONY LOAM.

The surface soil of the Chester stony loam, to an average depth of 10 inches, consists of medium or heavy brown loam, underlain by a red or yellowish-red clay loam which usually grades into stiff, red clay at depths ranging from 24 to 36 inches. Stones and bowlders are scattered over the surface and mixed with both soil and subsoil in quantities varying from 30 to 60 per cent, while in size the variation is from 2 inches to 4 feet in diameter. When the large bowlders are present upon the surface the small stones are often wanting, and the converse is also true. In local areas the soil contains a small amount of coarse material, while the subsoil is so completely filled with small stones and fragments of disintegrated rock that it is impossible to bore more than 8 or 10 inches. In texture the fine earth of the Chester stony loam very closely resembles the Chester loam.

The Chester stony loam occurs as small irregular areas, closely associated with the Chester loam. These small areas lie chiefly to the north of the Chester Valley, between French Creek and the east branch of the Brandywine River, though a few other areas are found in various parts of Chester County.

The areas of Chester stony loam at Rockville and to the southeast of Barneston are moderately rolling in topography, while the remainder of the type is rolling to hilly. Its usual occurrence is along the steep slopes and on the tops of hills and ridges, though it is sometimes found in narrow strips along stream courses.

On account of the irregularity of surface the superficial drainage of this type is good, and its texture is such as to conserve a favorable water supply.

The Chester stony loam is derived from the weathering of metamorphic rocks, principally gneiss, but some schist and trap. A few areas are derived from granite.

Where the slopes are not too steep and the surface is cleared of stone, good crops are produced upon this type, but much of it is used as permanent pasture, and to this purpose all the more stony and rough areas are best adapted. The average yields of the Chester stony loam are as follows: Corn, 50 bushels; oats, 35 bushels; wheat, 20 bushels; potatoes, 120 bushels, and hay, 1½ tons per acre.

The following table shows the average results of mechanical analyses of samples of fine earth of the soil and subsoil of this type:

Mechanical analyses of Chester stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14313, 14315	Soil	3.5	7.3	2.8	5.7	5.3	52.0	23.1
14314, 14316	Subsoil	4.3	5.9	2.3	5.5	5.5	45.1	30.9

CHESTER FINE SANDY LOAM.

The surface soil of the Chester fine sandy loam consists of brown, heavy, fine sandy loam 8 to 12 inches deep. On steep slopes, where the type is somewhat deficient in organic matter, the color is brownish yellow or even yellow and the texture in spots approaches a medium sandy loam. The subsoil, to a depth of 36 inches, consists of yellow fine sandy loam to fine sand, with a trace of medium and coarse sand and occasional small stones, and is generally underlain at greater depths by yellow fine sand.

The Chester fine sandy loam occurs only in small detached areas lying southwest from Westchester toward Westgrove and Kennett Square. The largest area of the type is located northwest of Marshallton, where it occurs as a long and narrow ridge, a characteristic example of its topographic features, which include also small, steep-sided hills and irregular slopes.

The Chester fine sandy loam is very susceptible to droughty conditions because of its open texture combined with its steep topographic position.

The type is derived primarily from a very fine-grained sandstone, which is often associated with scattering occurrences of limestone so deeply covered that it has no material influence on soil formation.

The type is one of the poorest in the county for general crops, but where its topographic position is suitable moderately early garden crops and potatoes could be grown with profit, and light farming could be advantageously followed.

At present the best parts of the type are used most often for growing rye and potatoes or for general farming and the remainder is left in forest.

The following table shows the results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Chester fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13687.............	Soil.........	2.1	10.4	6.9	23.3	19.7	26.8	10.8
13688.............	Subsoil.....	2.9	9.1	7.5	29.0	19.7	22.8	8.6

CECIL CLAY.

The surface soil of the Cecil clay, to an average depth of 9 inches, ranges from a brownish-red silt loam to a red silty clay loam, and in spots possesses the characteristic of pushing instead of turning well before the plow. The subsoil is more red than the soil, and the clay content increases with depth until at about 30 inches it becomes quite stiff and tenacious. At depths ranging from 4 to 10 feet the type passes into decomposing fragments of the rock from which it is derived.

Scattered upon the surface and disseminated through both soil and subsoil are fragments of gabbro, diorite, and some quartz. Originally there were scattered upon the surface a considerable number of large, dark-colored bowlders with rusty exteriors. Many of these rocks have been gathered and utilized as fences.

The type is relatively unimportant in the county because of its small area. It is limited to spots and strips along the Mason-Dixon line.

In topographic features it is usually an elevated rolling country and consists largely of irregular hills having a northeast-southwest trend. There are places, however, where it occurs as gently rolling areas.

Owing to its usual topography it is naturally a well-drained type, and there are few instances within the area where artificial drainage would be beneficial. The soil and subsoil absorb moisture well, and in dry times the type does not suffer from drought.

It is a residual soil derived from the decomposition of gabbro and diorite, and in places the latter rocks are associated with peridotite. Whenever such is the case, however, it is along the boundary line between Cecil clay and the Conowingo types.

The type is very well adapted to all of the general farm crops of the area, and, owing to the texture of the soil and character of the subsoil, it is naturally a productive type and responds readily to careful treatment. The effects of fertilizers are noticeable for a number of years.

Corn, wheat, oats, potatoes, hay, and apples are the crops grown, with the following average yields per acre: Corn, 70 bushels; wheat, 25 bushels; oats, 60 bushels; potatoes, 150 bushels, and hay, 1½ tons. Apples do fairly well, but no peaches are grown. The application of lime on this type seems to be beneficial to all crops and especially so for clover.

The following table shows the results of mechanical analyses of typical samples of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Cecil clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14323	Soil	0.9	2.8	1.3	3.5	6.5	60.2	24.8
14324	Subsoil	2.5	3.5	1.7	4.3	5.7	43.4	38.9

CONOWINGO BARRENS.

The surface soil of the Conowingo barrens, where it has accumulated to a sufficient depth for classification, consists of drab or rarely yellowish-brown silt loam, silty loam, or loam to an average depth of 12 inches. This material is extremely silty to the feel, and, although nearly devoid of coherence, yet is very firm and compact. These same textural characteristics are almost as prevalent in the subsoil, which has, however, a clay content somewhat greater than that of the surface soil and is consequently of heavier texture and slightly plastic, though still inclined toward incoherency. In its lower depths the subsoil changes in color to a brown.

The Conowingo barrens are principally developed in the southern part of the area, along the Mason-Dixon line. In the northeastern part of the county they occur as a series of small detached areas beginning about a mile south of Paoli and extending southwest for a few miles.

The topographic features of the type are rather uniform and consist of very narrow and low, steep-sided ridges, which in a few instances broaden so as to form small, flat-topped ridges. So narrow are some of these elevations that they could not be shown on the map, but their significance is such that where possible their positions have been indicated, even at some risk of exaggeration. In the south part of the area the barrens occur in larger areas as a succession of ridges and hills and small intervening hollows.

The Conowingo barrens are always ill drained on account of the position of the derivative rock. Serpentine underlies this entire formation and usually comes near enough to the surface to render the soil unproductive. In many places the soil is too thin to afford root space or sufficient moisture for growing crops, whereas in small depressions, or flat areas on the ridge tops, where the soil has accumulated to a depth of from 1 to several feet, the position of the underlying derivative rock renders drainage so defective that moisture is retained long enough to injure greatly or even to destroy any crop, and consequently no attempt is made to farm it.

This type of soil is residual and is derived from serpentine, which is an alteration product from the igneous intrusive peridotite. In the areas near the Mason-Dixon line this serpentine is closely associated with gabbro, which weathers into Cecil clay. The serpentine rock is soft, but owing to its chemical stability it weathers extremely slow.

In numerous places the greenish serpentine rock outcrops, and the entire formation is dotted with quarries from which much choice building stone has been taken and extensively used for the construction of dwellings within the county.

Owing to the thinness of the soil and its small water-holding capacity the type is almost sterile. There are no farms upon the type, and the region is wild and desolate and in marked contrast with the surrounding county. Where the rock comes to the surface there is no vegetation, and where it comes within a couple of inches of the surface there is usually no vegetation except a vine which gives to the hills a characteristic pink appearance. Where the soil has accumulated to a greater depth there is a scanty growth of scrubby white oak, red oak, and black-jack oak, stunted cedars, and dwarfed white pine.

The Conowingo barrens have no agricultural value, being very unsatisfactory even for pasture. In the southern part of the area the barren lands are owned largely by one mining company. Chrome and corundum are the principal paying mineral products, and in places where pegmatite veins occur with it the latter are often profitably worked for feldspar.

In the following table are given the results of a mechanical analysis of a sample of the fine earth of soil and subsoil taken from a flat upland topographic position, where without washing the soil had accumulated as fast as formed until it had acquired a depth of more than 3 feet.

Mechanical analyses of Conowingo barrens.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13701	Soil	0.3	1.6	1.0	1.5	2.7	75.7	17.1
13702	Subsoil	.2	1.3	.5	1.5	2.2	69.5	24.5

CONOWINGO CLAY.

The surface soil of the Conowingo clay consists of drab or brownish-gray silty clay loam or heavy silt loam from 9 to 12 inches deep. The subsoil consists of pale yellow silty clay loam, silty clay, or heavy silt loam and rests upon the underlying rock at depths ranging from 2½ feet to 15 feet. In the lower depths close to the underlying rock the subsoil has a greenish, gummy appearance. In a few localities both soil and subsoil are reddish and resemble Cecil clay; but such instances are where the serpentine has been largely decomposed into soil, leaving behind fragments of siliceous iron rocks, and the oxidation of these iron silicates imparts to the material a reddish color. If sufficient areas of this phase had been encountered, it would have been mapped as a separate soil type, because of its higher agricultural value.

The largest areas of Conowingo clay are located near the boundary line with Cecil County, Md. In the northeastern part of the county the type is found about a mile south of Malvern, where as a belt a little less than a mile wide it extends in a northeast-southwest direction for a distance of nearly 4 miles.

The topographic features of the type include very low, flat-topped hills and the shallow depressions between them. At irregular intervals rise the narrow ridges of the Conowingo barrens, which give to the type a more broken aspect than it ever presents within itself. The boundaries of such ridges are often sharply drawn and the Conowingo clay lies directly at the bases; but where the ridges broaden, as they commonly do after extending for some distance in abrupt outline, the Conowingo clay spreads over them.

The Conowingo clay is never well drained, and for most of the type drainage is very deficient. This is due not only to the closeness in texture of the type, but also to the position of the underlying serpentine, which in many places may be found at depths ranging from 2½ to 6 feet beneath the surface.

The type is residual, being derived from the same character of serpentine rock as the Conowingo barrens, and differs from the latter type mainly in topographic features and in the depth of its soil. Upon the gently rolling uplands and the gentle lower slopes adjacent to streams the rate of weathering is greater than that of erosion; hence the soil has a chance to accumulate.

Only selected fields of Conowingo clay are used for tilled crops, while more of it serves as pasture. The type is generally considered very poor for tillage purposes and most of it is very sour, owing largely to defective drainage. So pronounced is the acid condition that a single application of lime has, in some instances, effected a good crop yield, while on a part of the same field not limed the crop has been practically a failure. There is very little standing timber and many of the fields seem to have been abandoned and allowed to become covered with sage grass.

If adequately drained, limed, and manured the Conowingo clay would produce moderate yields of the staple farm crops and should yield excellent crops of timothy or pasturage. There are a few cases where the type has been built up by such treatment and all of the general farm crops of the region are grown with the following average yields per acre: Corn, 40 bushels; wheat, 15 bushels; oats, 35 bushels; and potatoes, 80 bushels. Timothy does fairly well, but clover does not make a satisfactory stand.

The following table shows the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Conowingo clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13699, 14333.......	Soil.........	0.5	2.6	1.4	3.4	4.6	61.6	25.7
13700, 14334.......	Subsoil.....	1.3	4.2	2.3	5.2	4.9	56.3	25.8

PORTSMOUTH SILT LOAM.

The surface soil of the Portsmouth silt loam consists of yellow silt loam from 8 to 12 inches deep. The subsoil to a depth of 36 inches consists of a mottled yellow and gray heavy silt loam or silty clay loam. Both soil and subsoil have a tendency to pack somewhat hard, and this gives the type the superficial field appearance of a clay.

There are only two small areas of the Portsmouth silt loam in Chester County, and these are located in the same southern extension of the county as the Norfolk silt loam.

The topographic features of the Portsmouth silt loam are nearly level or gently rolling, the mean elevation above sea level being less than 200 feet.

The drainage features of this type in Chester County are fairly well established, although near-by, low-lying areas in Cecil County, Md., need artificial drainage to obtain good results on account of the packed condition of the soil.

The Portsmouth silt loam is located in the Coastal Plain region and owes its origin to the poorly drained condition of certain loamy parts of the Columbia formation.

In its natural state this soil is covered with a growth of oak. The principal crops grown and to which this type of soil is best adapted are wheat, oats, grass, and pasturage. Wheat yields on the average 17 bushels, oats 30 bushels, and hay 1½ tons per acre. Corn does not do so well and yields about 30 bushels per acre. These yields apply to the well-drained soil.

The following table shows the results of mechanical analyses of the fine earth of soil and subsoil of this type:

Mechanical analyses of Portsmouth silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14345	Soil	0.1	1.0	0.5	1.1	4.6	72.4	19.6
14346	Subsoil	Trace.	.3	.2	.5	4.8	72.2	22.0

NORFOLK SILT LOAM.

The surface soil of the Norfolk silt loam consists of brown heavy silt loam from 12 to 14 inches deep. The subsoil, to a depth of 36 inches, consists of a yellow silty clay loam.

The Norfolk silt loam in Chester County comprises only a few acres in the very extremity of the wedge-shaped portion of the county which lies between Cecil County, Md., and Newcastle County, Del., coming to a point a few miles south of where it enters the Coastal Plain.

In topographic features the Norfolk silt loam is very nearly level in Chester County, and the adjoining area in Delaware extends for miles eastward, with level or but slightly rolling surface features; and similar large areas are found near by in the Coastal Plain region of Maryland, Delaware, and New Jersey.

Surface drainage is fairly well established on the type, and the subsoil is not so impervious as to render the downward flow of soil water too slow nor so open as to allow excessive drainage.

The Norfolk silt loam is derived from the weathering of beds of material which constitute portions of the Columbia formation.

The Norfolk silt loam is adapted to a wide range of crops. It is utilized for general farming and is also suited for truck and small fruit growing. Corn yields an average of 50 bushels, wheat 20 bushels, oats 30 bushels, and hay 1½ tons per acre. Much higher yields are secured in unusually good seasons, and the type can be made highly productive.

The following table shows the results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Norfolk silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14360	Soil	0.3	0.9	0.6	1.5	7.4	73.5	15.6
14361	Subsoil	Trace.	.4	.2	.6	6.7	67.7	24.1

MANOR LOAM.

The surface soil of the Manor loam consists of medium to heavy brown silty loam from 8 to 10 inches deep. In wooded areas which have not been cultivated for a long time the soil is yellow or yellowish-brown, and in this respect is in contradistinction to most soils, which become lighter colored under continued cultivation as a result of the depletion of organic matter. The surface soil not infrequently contains from 5 to 10 per cent of mica schist fragments from one-fourth inch to 3 inches in diameter, and occasional areas contain as much as 25 per cent of this material. Such areas, however, are most common in the northern part of the county. The subsoil, to a depth of 36 inches, consists of yellow or reddish-yellow heavy loam to friable silty clay loam or yellow clay loam, the former sometimes grading into the latter at a depth of about 18 inches; and again, the clay loam may immediately underlie the surface soil. The color of the subsoil grades from yellow to yellowish-red, the approach toward the red often being accompanied by an increase in heaviness of texture. The proportion of mica schist present in the subsoil is variable, fragments being in turn entirely absent, fewer, or more numerous than in the surface soil. Both soil and subsoil have usually a smooth feel, but local areas are somewhat gritty, a feature more pronounced in the subsoil than in the surface.

In the southwest part of the area the subsoil at an average depth of 24 inches usually becomes micaceous, the mica content gradually increasing until at a depth of 36 inches the soil mass consists largely of small mica particles, which render it feathery and fluffy, giving it also a greasy feel when rubbed between the fingers.

The Manor loam lies principally in one large body, extending in a northeast-southwest direction entirely across the county. The width of this area, which is about 14 miles near the Lancaster County line, gradually decreases until it is only 1 mile at the Montgomery County boundary.

The topographic features of the Manor loam range from gently to moderately rolling, with occasionally hilly areas. Sometimes the type occupies the lower and more gentle slopes of ridges and less frequently of hills, whose upper slopes and summits are occupied by the Manor stony loam.

Good surface drainage is secured by the sloping surface features of most of the type. In the northeastern part of the county, where the type is most steeply rolling, this ready surface drainage often causes destructive washing, but the greater part of this is due largely to the neglect which accompanies the field management of considerable areas of this type, and could be prevented, and in many cases easily remedied where it has already taken place, by careful tillage. The texture of both soil and subsoil is such as to maintain a good supply of moisture for crops.

The Manor loam is derived from hydromica schists, of which there are three colors, and the presence of schist fragments causes the type to be called, according to the color of the schist, "dark-slate land," "red-slate land," or "white-slate land." The productiveness of the three kinds follows the order named, but with the "white-slate land" this is due in part at least to texture, for the surface soil is lighter and the subsoil more micaceous in places.

In the southwestern part of the county, where extensively developed, the Manor loam is well adapted to general farm crops, but in the northeastern part, where adjacent to the Manor stony loam, it is only moderately productive. The natural forest growth, where still standing, consists mostly of chestnut and chestnut oak, with which are interspersed red, white, and black oaks and scattering trees of other kinds; but in the southwest part of the county little forest growth remains. The type is best adapted to the staple farm crops of the area, but is of considerably less value than the Chester loam.

Where best developed, in the western part of the county, corn yields 60 bushels, oats 40 bushels, wheat 22 bushels, potatoes 125 bushels, and hay 1½ tons per acre. The yields in the northeastern part of the county are not quite as high.

The following table shows the average results of mechanical analyses of samples of fine earth of soil and subsoil of this type:

Mechanical analyses of Manor loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13691,14349,14351.	Soil.........	1.9	3.5	1.3	5.2	11.1	55.3	21.4
13692,14350,14352.	Subsoil.....	3.0	4.7	1.7	5.9	9.7	50.2	24.6

MANOR STONY LOAM.

The surface soil of the Manor stony loam, to an average depth of 7 inches, consists of heavy loam, yellow or reddish-brown in color. On the surface and mingled with the soil are from 30 to 60 per cent of mica schist fragments. Most of the fragments are small and thin, and because of their thin schistose cleavage are called "slate," but larger pieces from 6 to 10 inches in diameter and from 1 to 2 inches thick are strewn over some areas. The subsoil consists of heavy loam or clay loam, yellow or reddish-yellow in color, these colors often alternating in layers a few inches thick. The amount of schist fragments in the subsoil is usually less, but sometimes more than in the surface soil, and it is seldom possible to bore more than from 6 to 10 inches. The type differs from the Manor loam principally in the amount of stones present and in its steeper topographic position.

The Manor stony loam is associated with the Manor loam in the large area adjoining Chester Valley on the south and extending across the county.

The topographic features of the type include upper slopes and the crests of steep ridges and hills and sharp descents to stream courses within the general areas of Manor loam. Such topography causes very rapid surface drainage and the soil where under cultivation is often injured seriously by washing.

The Manor stony loam is derived from dark-gray, reddish-yellow, or nearly white mica schists, which are for the most part well broken up, rocks of this material seldom being found, except as revealed in excavations.

The Manor stony loam is not a very productive soil. The least stony parts produce fair to light yields of the staple crops, but much of the type is not farmed and is covered with second-growth chestnut, several kinds of oak, and scattering trees of other varieties. Corn brings an average yield of 40 bushels, oats 25 bushels, wheat 15 bushels, potatoes 75 bushels, and hay 1 ton per acre.

The following table shows the average results of mechanical analyses of samples of the fine earth of soil and subsoil of this type:

Mechanical analyses of Manor stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14356, 14358.......	Soil.........	2.9	5.3	2.1	7.5	11.7	44.9	25.2
14357, 14359.......	Subsoil.....	6.3	9.6	2.8	8.8	15.3	36.3	20.2

HAGERSTOWN LOAM.

The surface soil of the Hagerstown loam consists of dark-brown, heavy, smooth silt loam or silty clay loam, in which the silt content is so high as to give the feel of a heavy fine loam, and the character of this material in actual field working is that of a loam. even though the clay content may be as high as 30 per cent. In local areas from 5 to 20 per cent of chert and small angular fragments occur, and in such places there may be sufficient grit present to give the soil the nature of a heavy brown loam rather than a silty loam, but it is probable that even in such cases the silt content is relatively high, though its presence is largely obscured by coarser material. At a depth of 10 inches the surface soil is underlain by a lighter brown, heavy silt loam, or silty clay loam, which is very smooth and free from grit. Such material is underlain at an average depth of 20 inches by a heavy, silty clay loam, yellow, fawn colored, light brown, or in places brownish red in color, and this at a depth of 30 inches sometimes grades into silty clay.

A frequent, though by no means universal, feature of the Hagerstown loam of the Chester Valley may be seen on some of the highest knobs and little hills, where the soil consists of a heavy, medium, or light loam, which in antithesis to the true type grows lighter with increasing depth, and at about 24 inches gives way to a light brick-colored, sticky, sandy loam of a mealy texture. In similar physiographic position are small areas of Hagerstown fine sandy loam, but their extent does not allow of their indication on the map. The two variations just mentioned are slightly less productive than the true type.

A phase of this type exists in the western end of the Chester Valley, extending from Pomeroy to the Lancaster County line, a distance of several miles, the width ranging from one-fourth to one-half mile. This material consists of a brown loam from 8 to 12 inches deep, underlain by a red or yellow heavy loam, or clay loam, which usually contains a considerable amount of mica, the mica content, however, not usually becoming pronounced at a depth of less than 24 inches. Notwithstanding its departure in texture from the typical Hagerstown loam, this phase is called limestone land and is valued as highly as the typical soil.

The location of the Hagerstown loam practically coincides with the physiographic division known locally as the Chester Valley, which enters the county on the southwest from Lancaster County and extends northwest in a belt from one-fourth mile to 2½ miles wide entirely across Chester and passes into Montgomery County.

The topographic features of the Hagerstown loam are those of moderately rolling valley land. The Chester Valley is bounded on each side by steep ridges of metamorphic rock formations, which in places broaden and so leave the valley-walls less abrupt. The surface of the valley itself is varied and uneven. Broad, well-rounded hills and flat-topped ridges of gentle contour rising from 25 to 100 feet above the general level of the valley floor are a prevalent feature. The slopes of these elevations are rarely so steep as to be a serious hindrance in cultivation, but in a few minor instances some damage has resulted from washing.

Adequate surface drainage obtains on this type, owing to the varied topographic features. The texture of the soil is such, also, as to maintain a most favorable supply of moisture for growing crops. Stream bottoms are for the most part too well drained to be classed as Meadow, and are used for tilled crops or permanent pasture, as the position may warrant.

The Hagerstown loam is derived from limestone of varying degrees of purity. The greater part of the type is free from chert and other impurities, but such material, especially near the sides of the valley, indicates the more impure character of the lime rock in those positions. The phase at the west end of the valley is derived from a micaceous schistose limestone which is interbedded with or veined in the purer limestone.

The Hagerstown loam is exceptionally well adapted to the production of general farm crops, producing excellent yields with a low or moderate application of fertilizers. Formerly large quantities of tobacco were grown, but this is no longer considered profitable.

The average crop yields of the type are estimated as follows: Corn, 75 bushels; oats, 40 bushels; wheat, 28 bushels; potatoes, 150 bushels, and hay, 2 tons per acre.

The following table shows the average results of mechanical analyses of samples of the fine earth of both soil and subsoil of this type:

Mechanical analyses of Hagerstown loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13689, 14347.......	Soil.........	0.4	1.5	0.6	3.3	7.4	69.4	17.2
13690, 14348.......	Subsoil.....	.5	1.2	.8	3.1	6.4	69.3	18.5

DEKALB STONY LOAM.

The surface soil of the Dekalb stony loam, to a depth of 8 to 12 inches, consists of a gray or drab medium to fine sandy loam or light loam. This grades into a subsoil of the same texture and color or into a light, yellow sandy clay or clay loam. Both soil and subsoil contain a large quantity of fragments of sandstone and conglomerate, and it is often impossible to bore more than from 12 to 16 inches. Large bowlders frequently occur upon the surface, and along steep slopes the underlying rocks sometimes outcrop.

There are three distinct occurrences of Dekalb stony loam within Chester County. The first extends in a narrow, broken strip along the north side of the Chester Valley, beginning a short distance above Bacton and reaching to the Chester-Lancaster county line. The second area, which is also broken and irregular, begins at Brandywine Manor and extends in a southwesterly direction, becoming gradually broader until it is 3½ miles in width, where it reaches the Chester-Lancaster line. The third area lies along the slopes of what is locally called the "Welsh Mountain." It begins where Chester, Lancaster, and Berks counties join, and extends in a northeasterly direction along the Chester-Berks county line to a point 3 miles northeast of Elverson.

The Dekalb stony loam occupies the steep slopes of the descent into the Chester Valley, and in the other areas above referred to it lies along the slopes and on the tops of hills and ridges, and as a type may be classed as rough and broken.

The Dekalb stony loam is derived from the disintegration of sandstone and some quartzite of Potsdam age.

The natural drainage of this type is good or excessive, and owing to its physiographic position and stony character it is not very productive. Only a small percentage of the type is under cultivation. The cultivated parts consist of a few small fields from which the stones have been removed. The remainder of the type is timbered chiefly with chestnut.

The crops grown are those common to the county, but as the area under cultivation is small and as the yields are irregular no satisfactory averages can be given.

The following table shows the results of mechanical analyses of samples of fine earth of soil and subsoil of this type:

Mechanical analyses of Dekalb stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13709	Soil	6.7	15.9	5.3	12.5	11.6	35.0	12.7
13710	Subsoil	7.3	16.5	4.5	10.4	11.0	31.2	19.1

DEKALB LOAM.

The surface soil of the Dekalb loam consists of gray-brown or brown coarse loam from 8 to 12 inches deep. This material ranges from a medium to a light loam, but there is always present enough coarse material to constitute a coarse loam, and in extreme cases a very gritty loam. The subsoil consists of gray-yellow or yellow plastic, gritty clay loam. In exposed topographic positions, where the soil has not accumulated to so great depths as on more level areas, the amount of the gritty material steadily increases with depth until it constitutes at 36 inches or below a gritty clayey sandy loam. On local areas and near the boundaries with the Dekalb stony loam small pieces of sandstone and quartzite occur, but never in amounts sufficient to interfere with cultivation.

The Dekalb loam is all located north of the limestone valley and most of it along the border of that valley, the largest area being about 3 miles north of Downingtown. It is generally associated with the Dekalb stony loam, and its topographic features include the lower slopes of hills and ridges whose upper slopes and summits are occupied by the Dekalb stony loam, and also adjoining small near-by level areas.

On account of the superficial features of the type surface drainage is ample, yet seldom excessive, and the texture of the subsoil is such as to maintain a good supply of moisture.

The Dekalb loam has been derived from Potsdam sandstone and quartzite, and the gritty material, which is a prominent characteristic of the type, represents the disintegrated particles of these rocks. In some instances the original soil has been modified somewhat by the material washed from higher surroundings.

The Dekalb loam, with careful treatment, will produce moderate yields of all the staple farm crops, but is noticeably less productive than the Chester loam. Corn brings an average yield of 40 bushels; oats, 35 bushels; rye, 18 bushels; wheat, 15 bushels; potatoes, 100 bushels, and hay, 1 ton per acre.

The following table shows the average results of mechanical analyses of samples of fine earth of soil and subsoil of this type:

Mechanical analyses of Dekalb loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13707, 14339	Soil	3.7	14.2	7.9	17.7	8.7	32.6	14.7
13708, 14340	Subsoil	3.6	13.6	7.4	15.4	7.1	33.6	18.7

DEKALB FINE SANDY LOAM.

The surface soil of the Dekalb fine sandy loam consists of gray, or rarely yellow, fine sandy loam or fine sand to an average depth of 9 inches. In a few spots the presence of organic matter gives the soil a dark-gray color, and in areas of similar consequence the sand is medium rather than fine. If this latter occurrence had been of sufficient extent it would have been mapped as Dekalb sandy loam. The subsoil consists of gray to yellow fine sandy loam to fine sand. With both soil and subsoil are found small bits of sandstone and quartzite, and occasional stones of the same material are on the surface and in the soil mass.

The Dekalb fine sandy loam is confined to small, narrow areas within the Dekalb loam and Dekalb stony loam or between those types and other soil formations.

The topographic features of the type include slopes below the Dekalb stony loam and small hills, ridges, and slopes within the type and also the Dekalb loam.

Surface drainage is thus well established, and the texture of soil and subsoil favors such rapid downward percolation of soil moisture that the type can ill withstand droughty conditions.

The Dekalb fine sandy loam is derived from a fine-grained gray sandstone of Potsdam age.

On account of its position and texture the type can be utilized best for light farming or in some instances for early garden crops. When farmed the Dekalb fine sandy loam is used for regular rotation, but the fields are so small and so associated with other types that no estimate is made of average yields.

The following table shows the results of mechanical analyses of samples of fine earth of soil and subsoil of this type:

Mechanical analyses of Dekalb fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14343	Soil	0.5	1.6	1.5	27.7	31.2	24.0	12.5
14344	Subsoil	1.2	1.8	2.0	38.7	23.8	18.5	13.4

PENN LOAM.

The surface soil of the largest areas of the Penn loam as it occurs in Chester County consists of loose medium brown loam from 9 to 12 inches deep. The subsoil consists of light-brown, gray-brown, or rarely reddish-brown heavy loam to clay loam. With this occurrence in much smaller areas is a dark Indian-red phase of which the soil consists of red heavy loam or silty loam to an average depth of 8 inches and the subsoil of red heavy silty loam or silty clay loam to a depth of 36 inches. Bits and fragments of sandstone to the extent of from 5 to 15 per cent are frequently found with the soil and subsoil. Along the Schuylkill River and for 1 to 2 miles back therefrom the Penn loam consists of heterogeneous material forming small, yet diverse, areas, not of sufficient extent to appear on the map and which when considered in their entirety may be readily grouped under the following description: Medium brown loam containing enough medium and coarse sand to give the effect of a coarse loam to an average depth of 10 inches. The subsoil consists of light-brown to grayish loam or rarely clay loam containing even more coarse sand than the soil, and in the most exposed topographic positions, such as steep slopes or sharp, narrow little ridges, this material sometimes grades at from 15 to 24 inches into heavy sticky sandy loam, which finally rests upon a mass of sandstone fragments and sandy loam. Areas of a sandy loam, which might be classed as Penn sandy loam, are of occasional occurrence in the northern part of the formation, but these are of importance not from their extent, but because they furnish desirable spots for the production of potatoes in a section where soils well adapted to this purpose are comparatively scarce. The largest areas of this kind are at the northwest corner of the county between Chestnut Hill and the Schuylkill River.

The Penn loam lies in the northern part of the county, forming a belt about 2 miles wide at its eastern extremity between Valleyforge and the Schuylkill River, and thence in its northwesterly course, widening as the distance from the river to the metamorphic rock formations to the southward increases until its general width is about 6 miles.

The topographic features of the Penn loam of Chester County are much more irregular and broken than is the general occurrence with this type. A succession of ridges, usually narrow, but in some cases broad, lie in a position generally parallel to the Schuylkill River. In places near the river these seem much like benches, but with increasing distance hills more or less rounded and sharp ridges between which the streams have cut steep courses make a much more diversified and broken topography. Thus while moderately sloping areas of considerable size are a feature of the Penn loam level areas of any considerable extent are rare, and steeply rolling areas are common, especially with the approach toward the formations of metamorphic rocks.

Drainage is well established on most of the Penn loam. Small depressions sometimes need artificial drainage, whereas steep ridges and hills are more or less susceptible to drought. A pertinent problem is presented in the tendency of the soil to wash on steep slopes. Through careless farming, most common on rented farms, destructive gullies have been allowed to form in some cases, and thus much injury has resulted. Contour plowing and cultivation would be a sufficient preventive where the slope is not too steep, and would be highly beneficial even on the steepest slopes, which can be well controlled only by terracing.

The Penn loam is derived from brown, red, yellow, and gray shales and sandstones. It often happens that a brown loam immediately overlies red shales and sandstones, whereas a red loam would naturally be expected. This is due in part to the fact that the shales are frequently laid down in beds of alternating colors, and as these vary greatly in thickness an upper layer of brown shale has been entirely disintegrated in the formation of the upper layers of soil, which are thus superposed oftentimes on a well-defined Indian-red subsoil in turn resting upon beds of deep red shale and sandstone.

Many other variations in the sandstone rock may be seen, but perhaps the most important is that of a gray or light-brown, coarse-grained sandstone, which in places approaches a conglomerate very similar to that in Montgomery County from which is derived the Dekalb gravelly loam. The coarse material is not coarse enough, however, to give rise to the fine gravel which is a primal characteristic of that type; but it does form the very coarse loam found for some distance back from the Schuylkill River. This loam is quite distinct from a heavy sandy loam which it is locally called, for even though the amount of coarse sand is so prominent as to cause a coarse, gritty feel, the amount of the finer grades of soil present is sufficient to form a medium to heavy loam.

The Penn loam is best adapted to the production of the staple farm crops of the area. The brown Penn loam is in general a deeper soil than the red, the underlying rock being a greater distance from the surface, and as a natural sequence it is somewhat more productive.

The crops grown and average yields are: Shelled corn, 55 bushels; oats, 30 bushels; wheat, 20 bushels; rye, 25 bushels; hay, 1½ tons, and potatoes on the sandy phase, 150 bushels per acre.

The following table shows the average results of mechanical analyses of the fine earth of soil and subsoil of the Penn loam:

Mechanical analyses of Penn loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13711, 14362.......	Soil.........	1.4	7.2	4.5	10.5	14.1	41.8	20.4
13712, 14363.......	Subsoil.....	1.6	7.9	4.4	10.1	13.7	35.3	27.0

LANSDALE SILT LOAM.

The surface soil of the Lansdale silt loam consists of brown or slate-colored medium to heavy silt loam from 10 to 14 inches deep. In local areas the clay content may be sufficient to constitute a clay loam, but in such cases the high silt content keeps the soil very mellow, and in working its physical characteristics are those of a heavy silty loam or silt loam. The subsoil, to a depth of 36 inches or more, consists of silty clay loam, or, in places, of a heavy silty loam grading into a silty clay loam at an average depth of 20 inches. This material is of a pale yellow, light drab, or gray-yellow color, seldom well pronounced, but usually of a lighter shade than the soil of the surface. The texture of the soil is such that it may be kept with comparatively little effort in a fine mellow mechanical condition, and this constitutes a very desirable feature of this type, for although a comparatively heavy soil it is not exacting as to the moisture conditions under which it may be worked.

The Lansdale silt loam is not as typically developed as across the river in Montgomery County, nor is its extent nearly as great. The two principal areas lie south of Spring City and Phœnixville, while small areas are scattered about the Penn loam formation.

The topographic features of the Lansdale silt loam range from gently to moderately rolling, and in general the surface of the type is less dissected than is the Penn loam with which it is associated. The drainage features of the type include a surface sufficiently rolling to secure adequate superficial drainage, while the texture of soil and subsoil is such as to allow a moderate downward percolation of moisture, at the same time retaining enough to afford a favorable supply to growing crops.

The Lansdale silt loam is derived from fine-grained sandstone and shale of Mesozoic age. These rock formations, which are usually brown or gray in color, have weathered more deeply than the coarser-grained rock from which the Penn loam has been derived and decomposition has been more complete.

The Lansdale silt loam is well adapted to the production of all the general farm crops of the area and is a little more productive than the Penn loam. In Montgomery County, where the type is more extensively developed, it is found to produce a little better quality of wheat than the Penn loam. Where well drained the type is well adapted to potatoes, being surpassed only by the heavy sandy loam spots in the Penn loam.

Corn brings an average yield of 58 bushels, oats 35 bushels, wheat 20 bushels, rye 25 bushels, hay 1¾ tons, and potatoes 135 bushels per acre.

The following table shows the results of mechanical analyses of the fine earth of soil and subsoil of the Lansdale silt loam:

Mechanical analyses of Lansdale silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13713	Soil	0.1	1.0	1.1	4.9	5.9	68.1	18.7
13714	Subsoil	.1	1.1	1.1	4.5	5.3	65.2	22.0

DEKALB SHALE LOAM.

The surface soil of the Dekalb shale loam consists of brown, blue-brown, red-brown, drab, or rarely red, light, or medium silty loam, containing from 5 to 50 per cent of stone in the form of broken bits of shale or sandstone. Where the minimum or only a small amount of shale is present on the surface the soil has been included in this type, because much greater amounts are present in the subsoil or because the area is too small to be mapped separately. The surface soil is for the most part open and easy to work, a characteristic intensified by the presence of the sandstone particles and shale. The subsoil, which, with increased depth, grows gradually heavier in texture, consists of a heavy silty loam which often grades into a silty clay loam. The amount of shale and sandstone fragments increases with depth and is often sufficient to prevent boring at from 6 to 30 inches, the average depth being about 20 inches. The amount of shale and sandstone present depends primarily upon the topography. On steep and exposed places sandstone bed rock lies so near the surface that the plow rides on it and bed rock underlies the entire formation at depths ranging from 6 inches to 6 feet, the average probably not exceeding 4 feet. Immediately overlying the parent rock there is commonly a mass of sandstone fragments with the interstices filled with soil.

The Dekalb shale loam occurs only in small areas, of which the two largest occupy the bluffs along the Schuylkill River north of Phœnixville and a long, narrow ridge extending from thence westward. Other scattered small areas are associated with the more important members of the Penn series.

The topographic features of the Dekalb shale loam are always broken and often steep, as the greater portion of the type occupies river bluffs, narrow ridges, or steep hills.

Drainage is excessive on most of the Kekalb shale loam, as the slopes are so steep that the surface water runs off before the soil has a chance to absorb it, or the shale is so near the surface that little water can be stored for the use of crops. In a few places where the bed rock is arranged horizontally the ground water can not percolate downward, and so causes seepage along the adjoining slopes. Such areas are almost worthless, as crops suffer alternately from excess of moisture and drought. In favorable locations, however, where the soil has accumulated to a considerable depth the type maintains a favorable supply of moisture for growing crops.

The Dekalb shale loam is derived from Mesozoic sandstone and shale. Some of this rock is in place, but much of it has been subjected in some degree to the processes of metamorphism, caused by the elevation of the underlying rock formations which often come within a few feet of the surface.

The Dekalb shale loam is moderately well, or poorly, adapted to the production of the general farm crops of the area, depending upon the position of the underlying rock or mass of shale fragments. Where decomposed to a considerable depth and well drained, potatoes can be grown to advantage. Where subject to seepage it can be used best as permanent pasture.

Crop yields are very variable, as they depend largely upon the proximity of the shale to the surface, and thus, in years of drought, are very low. Corn yields from 30 to 50 bushels, oats 15 to 50 bushels, wheat 8 to 25 bushels, and hay from one-half ton to 1½ tons per acre. Oats seem especially dependent upon the season, and good yields are secured only when the rainfall is well distributed.

The following table shows the results of mechanical analyses of samples of the fine earth of soil and subsoil of this type:

Mechanical analyses of Dekalb shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14366	Soil	3.8	5.4	3.3	16.1	19.2	37.4	14.9
14367	Subsoil	2.1	5.8	3.0	11.4	13.0	40.4	24.3

PENN STONY LOAM.

The surface soil of the Penn stony loam consists of brown-red, Indian-red, brown, or bluish-gray silty loam from 8 to 12 inches deep. The subsoil consists of Indian-red, brown-red, or bluish-gray heavy silty loam, which grades into a silty clay loam at an average depth of 20 inches. In places, however, the surface soil is underlain immediately by silty clay loam. From 10 to 60 per cent of shale and small sandstone fragments are of common occurrence in the Penn stony loam, but this is not a constant feature. The stone content is variable, but on the principal part of the type consists of blue or gray flaggy sandstones, and bowlders of sandstone which are sometimes conglomeritic. In spots igneous bowlders have been intruded through the surface, but where of sufficient extent to affect the soil formation such areas have been mapped as Chester stony loam.

The Penn stony loam is all located in the northwestern part of the county. The principal areas are on or near Chestnut Hill, while small areas are scattered between there and the Schuylkill River.

The topographic features of the Penn stony loam are always hilly and sometimes mountainous, and consequently surface drainage is always rapid. When large amounts of shale are present and the soil is shallow the type is very susceptible to drought, but in other cases at least a fairly good supply of moisture is retained.

The Penn stony loam has been derived from Mesozoic sandstone and shale, which in cases have been metamorphosed in varying degree, but only seldom to an advanced stage.

In adaptation to crops the Penn stony loam depends on the amount of stones present and topographic position. The most level and least stony parts are fairly well suited to the production of general farm crops, but most of the type should be used as pasture or left in forest. Much of the type is now used for forestry purposes, but from the small fields cultivated fair yields of corn, oats, wheat, and grass are obtained in moist seasons.

The following table shows the results of mechanical analyses of samples of fine earth of soil and subsoil of this type:

Mechanical analyses of Penn stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13953	Soil	2.1	4.4	2.7	9.3	10.7	49.1	21.2
13954	Subsoil	1.5	3.7	2.6	8.4	8.6	44.2	30.3

LICKDALE CLAY LOAM.

The surface soil of the Lickdale clay loam, to a depth of from 6 to 8 inches, consists of drab or gray clay loam. As the type owes its origin in most places to the accumulation of fine material which has been very slowly transported by washing from the gently or rarely moderately rolling surroundings, its texture varies. In places the silt content is prominent, but this is not a constant feature, and again the soil may be a very heavy loam. The subsoil consists of drab clay loam, which often is mottled in its lower depths. This material may extend to a depth of several feet, depending chiefly upon topographic position, or it may rest upon the underlying formation at depths ranging from 3 to 4 feet.

The Lickdale clay loam is of small extent, including one area at Westchester, another near Rockville, and a few scattering patches.

Natural drainage is not well established, and most of the type requires artificial drainage if it is to be used to advantage for tilled crops.

The Lickdale clay loam is not especially adapted to any crops, but it can be best used for mowing and pasture lands. Where sufficiently drained fair yields of hay, corn, and oats are obtained.

The following table shows the results of mechanical analyses of samples of fine earth of soil and subsoil of this type:

Mechanical analyses of Lickdale clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14368	Soil	1.9	6.5	2.0	3.9	6.0	56.5	23.2
14369	Subsoil	.6	1.9	.9	2.5	4.5	49.2	40.1

ROUGH STONY LAND.

The Rough stony land includes parts of four different soil formations, and thus represents similarity of condition rather than likeness of soil texture or derivation. The largest areas are in the northwestern part of the county on or near Chestnut Hill, where the type is associated with the Penn series. There the soil corresponds very closely with the Penn stony loam, but the topography is so broken and the ground so stony that its agricultural value is distinctly inferior to that type. This material is derived from the New Red sandstone formation, and the stones, rocks, and ledges are of sandstone, some of which has been hardened considerably by the processes of metamorphism. Other areas are found with the Manor series on the steep ridge which extends from near Gulf Mills westward for several miles. The type is here derived from the semicrystalline mica schists of the Manor series and bears a relation to the Manor stony loam similar to that it bears to the Penn stony loam.

Areas associated with the Chester series are widely scattered, but are most numerous north of the Chester Valley, and associated in many cases with the Chester stony loam.

The Dekalb series also includes small areas of this type which occupies steep-sided ravines and sharp, steep slopes, and crests of ridges.

Small areas within the Rough stony land have been kept cleared of forest growth and are utilized as pasture, not without profit when bought after the work of clearing has been done, but most of the type is left in forest, the purpose to which it is best adapted.

MEADOW.

Scattered over the county are small areas adjacent to streams which are subject to overflow or kept in a condition too moist to be used for tilled crops. There areas have been mapped as Meadow.

The soil in such areas is largely alluvial, being derived from material washed in from the surrounding slopes or transported from greater distances during flood time.

The largest areas are along the Brandywine Creek, where the type affords excellent pasturage for large herds of cows. Most of the type is used as pasture, a purpose for which it is well and best adapted.

AGRICULTURAL METHODS.

Within the memory of the present generation agricultural methods in Chester County were much less intensive than now, and the land was turned reluctantly, the farmers preferring to keep as much of it in grass and pasture as possible. This feeling has gradually disappeared, and methods of farming throughout the county have steadily grown more efficient. The land is well turned, as a rule, with two-horse plows to a depth of 6 to 7 inches, and this is not too deep for all the heavy soils. Some plow to a depth of only 4 inches, which is much too shallow for all types of the area except the fine sandy loams, sandy areas within the Penn loam, and the lighter parts of the Brandywine loam. The plowing is done in the fall for wheat and winter rye and in the spring for corn and oats. Owing to the ravages of cutworms in some sections it is recommended that corn ground also be plowed late in the fall where the topographic features of the field are such that the soil will not be injured by washing. This will not only kill many of the worms, but in the case of the heavy loam and clay loam will subject the ground to the beneficial action of a more thorough freezing and thawing during the late winter and early spring months.

The amount of preparation given fields before planting, and of cultivation of tilled crops during the growing season, varies greatly; but the degree of financial success attained by farmers bears a very definite relation to the thoroughness with which this is done, and demonstrates conclusively the necessity for intensive preparation and cultivation of the soil, as well as the profit of so doing. For wheat, some of the best farmers roll the land immediately after plowing, then go over it with a spring-tooth or disk harrow three or four times or more, according to the condition of the soil. If still lumpy, the ground is rolled again ahead of the drill. For oats, the land is harrowed only once or twice, and corn receives preparation about half way between this and that given wheat. Corn is planted in check rows 3½ feet apart so as to allow cultivation both ways, or it is drilled in rows with the hills from 12 to 15 inches apart, 1 kernel to a hill. One of the most efficient practices noted consists of going over the corn twice with a weeder and three times with a double riding cultivator, the last cultivation being in the last part of June, just before harvesting the wheat. Very little hand hoeing is done, and the weeder is probably not used by more than one-fourth of the farmers.

The importance of maintaining land in a productive state is generally recognized in Chester County, and only a small part has been allowed to become depleted. As it has been the custom to keep large numbers of stock, most farmers have been able to apply liberal dressings of homemade manure, and in addition, a great deal is brought from Philadelphia stables. The farmyard manure is cared for better than in many places, but there is still a great deal of waste in the aggregate from the failure to use sufficient absorbents and from exposure in the yards, thus allowing much loss in the drainage therefrom. The manure is variable in quality and not as valuable in many cases as it might just as well be without additional cost, and for this reason it is earnestly recommended that farmers study carefully how to feed balanced rations and how to produce as much clover as possible to feed upon the farm, thus obtaining more economical feed and increasing the value of the manure.

The manure is applied to corn in amounts ranging from 6 to 15 two-horse loads an acre. The large number of manure spreaders in use is exceptional, and thus much of the manure is applied to the best advantage. In addition there is given a dressing of from 150 to 800 pounds of acid phosphate, bone and phosphate, or of a complete commercial fertilizer of grades costing from $18 to $28 a ton. When no manure is applied, from 500 to 1,000 pounds of commercial fertilizer is used. Some of the best farmers apply the manure in winter, add 300 pounds of acid phosphate before plowing and from 100 to 150 pounds of complete fertilizers at time of planting.

Potato land receives from 6 to 10 loads of manure and generally from 300 to 1,000 pounds of commercial fertilizers costing about $30 a ton. Occasionally the amount of the latter is increased to

1,500 or even 2,000 pounds, and then no additional application is made for wheat the following year. The oat and millet crops generally receive no application of fertilizer, but sometimes are given from 100 to 300 pounds of a $22 brand. To wheat is applied from 100 to 600 pounds of fertilizer costing from $22 to $28 a ton and in addition from 6 to 8 loads of manure, when available.

Formerly it was the practice to lime land at least once during the course of a rotation, the amounts applied ranging from 20 to 40 bushels an acre, but this has been largely discontinued. In recent years, too, considerable difficulty has been experienced in getting satisfactory stands of clover. It dies out in spots, and some farmers attribute this to the excessive use of acid phosphate. The land becomes sour, and in some cases better stands of clover have been secured after a liberal application of lime. Such dressing seems to be necessary only once in from three to six years. The experience of others indicates that in some cases at least there is no difficulty in obtaining a good stand of clover if the land is thoroughly prepared for the wheat and so is in a condition of good tilth.

The character of machinery and farming implements of all kinds is so far above the average that as a whole they may be termed excellent. Besides tillage implements farmers are well supplied with grain drills, mowing machines, hay rakes, tedders, and horse forks. Hay loaders and corn harvesters are not uncommon, and self-binding reapers are on nearly every farm. Round silos, which are numerous, are filled by corn-cutting outfits, in which the power is supplied by a traction engine. These outfits are hired in most instances, although some are owned by the farmers on the cooperative plan.

Corn for husking is cut from 1 to 2 feet above the ground, shocked, and husked in the fields. The stubs are cut down either with a heavy hoe or an old mowing machine. This is done usually during the late fall, so as not to retard the next spring's work.

The crop rotation which has been considered the standard is corn, followed by oats or potatoes, wheat, and grass. General change of conditions has led to many adaptations of this rotation to suit different locations, soils, markets, and individual tastes. Of these changes the most common is the replacement of a part of the oats in the second year of rotation by ensilage corn, millet, spring rye, or by increasing the acreage of potatoes. The practice of sowing crimson clover in the corn when it is "laid by" is gaining favor in some parts of the county, but this is usually plowed down the following spring rather than kept for mowing, which has been successfully done elsewhere by cutting the corn stubs close to the ground during the winter. Wheat is almost universally the sole crop in the third year of rotation, though some farmers substitute rye on a part of the ground. Timothy is seeded with the wheat or rye, and clover is sown the following spring.

The land is then mowed as long as it is profitable to do so, which nowadays is from one to three years. Formerly fields were mowed at least three years, but, owing to the spread of noxious weeds, plantain, cinquefoil, daisies, and wild onions, fields are now shorter lived. The second crop of hay is seldom mowed, but the fields are pastured when the grass is well started, after the removal of the first crop, and again for two or three entire seasons when it is no longer considered profitable to harvest the hay.

AGRICULTURAL CONDITIONS.

The general appearance of Chester County betokens prosperity to a degree that is rarely attained. The excellence of the farm dwellings, barns, outbuildings, and fences, coupled with extraordinary neatness of surroundings, lends a supreme distinction to the tone of the county, indicative of thrift, vigor, alertness, and prosperity. This outward appearance also makes evident that the agricultural success is not transitory, but that it has been an attainment of many past generations, which, in general, is maintained at the present time. Failure to adapt oneself to the gradual evolution of conditions, and consequent unprofitable farming, is occasionally revealed, but the county is unusually free from illustrations of this kind.

An insight into the working conditions of the farmers discloses an agricultural practice, as already described under the heading "Agricultural methods," an understanding and intelligence which make plain why the external appearances are so indicative of prosperity. The Grange is well organized, and this, with local coteries, constitutes a very attractive feature of farm life which is both profitable and enjoyable.

The hard work attending farm life, contrasted with the seemingly easier life which the farmer sees when he goes to town, proves distracting to those who fail both to estimate correctly the ratio between income and expenses and to realize the possible advantages they may already possess or attain, and it is said that this tendency toward discontentment of condition is slowly increasing, but fortunately it has not yet been strong enough to affect seriously the good tone of the farming class or to impair thrifty agricultural development.

No more crucial test, perhaps, can be applied to the actual conditions of farming within a given area than the promise which it offers to the average young man who has to make his own way and is willing to begin on a small scale the acquirement of a comfortable living for himself and family, a good high-school education for his children, and a sufficient reserve fund to support himself and wife comfortably in old age, as a reward for steady work and intelligent effort. Such inducements Chester County offers, it is believed, in exceptional degree, and, at the same time, the county is a very attractive section in which to live.

The proportion of farmers who live on and till their own farms varies in different parts of the county, but the range is estimated at from 60 to 75 per cent. Of the farms in the county perhaps three-fourths are encumbered more or less, the encumbrance averaging about one-third of their value. Many, but not all, of these obligations are being steadily reduced.

The greater number of the farms rented are leased on shares, the owner furnishing, by the most common arrangement, one-half the commercial fertilizer and one-half the seed and receiving one-half of the annual products, while the tenant for the other half of the products furnishes the stock, tools, labor, one-half of the fertilizer, and one-half the seed. A few farms are rented outright for a cash sum. Some of the renters make enough money so that in time they are able to own a farm, but others just drift along saving little or nothing above their living expenses. The owner generally, but not always, gets a fair return on the investment.

Farms range in size from 30 to 200 acres, the average for the entire county being, according to the Twelfth Census, 72.1 acres. Farms were originally much larger, many containing from 200 to 500 acres, but they have been much reduced in size, owing to the division of estates among heirs and the development of a more intensive agriculture.

Labor has generally been plentiful at a satisfactory rate of wages, but for the last few years there seems to have been a tendency toward a decrease in the supply, and its character is also deteriorating, owing to the fact that some of the best men buy farms of their own and others leave farm work for something else that they think promises better returns for the work done.

An average price for a good farm hand is $18 a month and board by the year, or $22 a month and board for eight months. Many of the men have a horse and arrange to work it enough on the farm to pay for its keeping. Married men are given the use of a tenant house, a garden, the crop grown from 1 bushel of seed potatoes planted usually with the farmer's crop, and from $25 to $30 a month. Day help ranges in price from 75 cents to $1.25 a day with meals, according to the season and the efficiency of the labor. Considerable labor is hired in the fall to husk corn by the shock, the price ranging from 4 to 8 cents, depending upon the supply of labor and the lateness of the season.

Dairy products constitute at present the principal source of income, having largely replaced, within the last few decades, the fat steers and wheat which were formerly the principal products. The preeminence of dairying and the converting of so many farm products into manure is largely accountable for the prosperity of the area, for the soils have thus been maintained in a very productive state. Milk is shipped principally to the wholesale market in Philadelphia or to local creameries, depending largely upon the distance to a railway station. Considerable money has been lost in the former manner by sending to unreliable dealers. Most of the local creameries are proprietary, but a few are run on the cooperative plan. Both purchase milk on the basis of the Babcock test for butter fat, and the skimmed milk is sold back to the farmers as desired. There is a condensed milk factory at Malvern, in the eastern part of the county, which also buys large quantities of milk.

There are few pure-bred cows, and thoroughbred bulls are too scarce, though some attempt is made to use a high-grade bull. Many of the cows are common stock, in which the characteristics of any particular breed are not sufficiently prominent to allow of their classification, but Shorthorn, Jersey, Holstein, and Guernsey grades are all well represented.

Hay is the product of next importance, and with those who do not keep dairies it is the primary money crop. The hay is baled on the farm and sold to local buyers or to local commission men, the city dealers generally declining to buy direct of the farmers. Wheat, which with some is of more importance than hay as a money crop, is of good quality for eastern-grown grain, and is graded locally as No. 1 and No. 2, but if classed on the same basis as the western-grown product it is No. 2 and No. 3. The oat crop is nearly all consumed at home, but potatoes are an important source of income with some, and a secondary money crop with many.

Most of the corn is fed on the farm, but it is sold by those who do not keep dairies or fatten steers. Steer feeding, which was once extensively followed, has assumed an unimportant position and is still declining. Pork has become a more important product than beef. A great many farmers sell from 8 to 25 hogs in a single season. Berkshires and Chester Whites are the most numerous of all breeds, and are sold to local dealers, who ship them. About one-half are dressed at home and one-half shipped alive, the preferred weight being from 150 to 200 pounds. Most of the rye grown is mixed with corn and fed to pigs. Poultry brings to many farmers an income which can not be ignored, and with some it is an important adjunct. In some parts of the county about one-half the horses required for farm use are raised, and in the eastern part of the Chester Valley there is a large farm devoted to the production of choice driving and coach horses by crossing Hackney stallions with Kentucky mares.

The fruit product is not large. There are no commercial orchards, but many farmers have small apple plantings which supply their own needs and furnish some to sell. Pears, peaches, quinces, cherries, and small fruits are generally grown for a home supply, and small quantities are sold. The San Jose scale is a serious and increasing pest to the fruit interests, and in this connection may be mentioned the Hessian fly, which in some seasons injures the wheat crop, and the cutworm, which sometimes necessitates a replanting of part of the corn fields.

The production of mushrooms and carnations has been extensively developed. For the former the manure is brought from Philadelphia in car lots, placed in piles, shaped, moistened, covered with soil, and then turned just before sufficient heat develops to "burn" the manure. This process is repeated every few days for a period of from four to six weeks. This work is done in the spring, so that the beds may be started from the 1st to the 15th of July. The treatment given is described in publications of this Department, and is not given in detail here. The best growers try to have their mushrooms ready for market as soon as possible after October 1, the picking season extending to about Christmas. Special greenhouses are constructed by the most progressive growers, but combination houses are also used.

The carnation belt extends through the southern part of the county. The carnations are started in the spring from slips or twigs taken from old plants, bedded in sand, and later transplanted in greenhouses into a soil consisting of Chester loam, mixed with pig manure and some lime, or with soil taken from the mushroom beds. The flowers are cut and shipped principally to commission men in Philadelphia. Another special industry is represented at Westgrove by the largest rose growers in the world.

To the adaptation of soils to crops little attention is paid as far as the standard rotation is concerned, and these crops are grown by nearly everyone regardless of the soil types upon which his farm is located. The most attention is paid to the potato crop by the average farmer, who generally tries to select a well-drained area of as light textured soil as he possesses. The fact that one type of soil yields a better quality of wheat than another is occasionally recognized, but is practically never considered of sufficient importance to cause a change in the use made of the soil more poorly adapted to this purpose.

The transportation facilities of the county are extensive. The crossing of the area by the Chester Valley has been of great importance as a general transportation factor, and consequently for the development of numerous towns which have followed the course of transportation. The four tracks of main line of the Pennsylvania Railroad extend across the county along the course of the valley, and numerous branch lines of this and other companies render exceptional service over the area. There is some complaint, however, that freight rates are unreasonably high.

Numerous trolley lines add greatly to the convenience of traveling, and several main roadways constructed on scientific principles, in addition to the good dirt roads which ramify through the county, make all parts of the area easily accessible.

The nearness of the area to Philadelphia causes that city to be the principal market for all farm products. The fact that so good a market is so near at hand is largely accountable for the prosperous agricultural condition. The extent of the markets within the county, however, has much to do with its general welfare, as they consume great quantities of milk, potatoes, garden vegetables, and poultry products. Of these towns the most important are Westchester, Phœnixville, Spring City, Coatesville, Parkesburg, Malvern, Oxford, Downingtown, Kennett Square, Westgrove, and Avondale.

SOIL SURVEY OF UPSHUR COUNTY, WEST VIRGINIA.

By **A. M. GRIFFEN** and **ORLA L. AYRS.**

LOCATION AND BOUNDARIES OF THE AREA.

Upshur County lies slightly to the northeast of the center of West Virginia, in about 80° west longitude and 39° north latitude. The county has an extent of 330 square miles and is somewhat irregular in shape, with an extreme length of about 30 miles and a width of about 16 miles. It is bounded on the north by Harrison and Barbour counties, on the east by Barbour and Randolph, on the south by Randolph and Webster, and on the west by Lewis. Buckhannon, with a population of 3,000, is the county seat and principal town, and is located in the north-central part of the county.

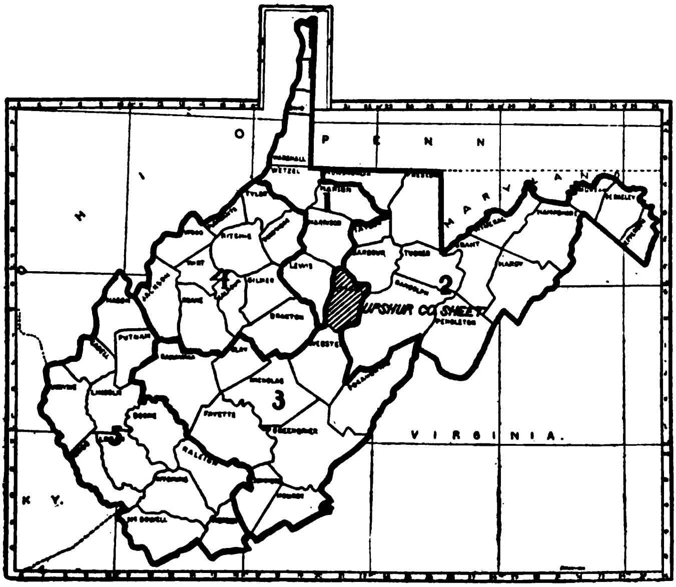

Fig. 5.—Sketch map showing location of the Upshur County area, West Virginia.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

In 1765 two deserters from the British army at Fort Pitt made their camp at the mouth of Turkey River, a short distance north of the present town of Buckhannon. The French and English were then at war, and the fugitives spent their time in hunting and trapping until peace was declared, nearly two years later. They then returned to the settlements on the south branch of the Potomac, hoping to persuade settlers to join them in the newly explored region. In this they were successful, and in 1769 farms were located and improvements started, and during the next few years many permanent settlements were made along Turkey Run, Hackers Creek, and the Buckhannon River.

Beginning in 1801 many New England families made the long overland journey across the mountains and established homes within the present boundaries of Upshur County. Permanent settlements were made at French Creek, Sago, Hollygrove, and other points, and this class of settlers continued to come for the next fifteen or twenty years. Drawn as they were from different points, and coming from different ancestral stocks, the habits and customs of the Virginians and New Englanders were not always in accord, but a gradual blending took place, and a large majority of the present residents of the county are descended from these two sources of early immigration.

Considerable trouble was experienced in the early days as a result of conflicting land grants. In a few cases farmers were compelled to pay a second and third time for their land before receiving a clear title. This feature was discouraging, and about 1830 many of the New Englanders moved to Illinois and others to far western points, where more fertile lands with clearer titles could be secured. The settlements suffered from Indian depredations in common with the other frontier points of that period.

Corn was the principal crop cultivated by the Virginians, as it was also their main source of food. The New Englanders brought seeds of the principal garden vegetables, which added considerable variety to the pioneer's table. Sheep and cattle were introduced in 1809 and 1810, and the grazing industry has gradually developed until it has become the leading feature of the county's agriculture.

The first steps toward organizing the county were taken in 1848, when an act was introduced in the Virginia legislature with that object in view. The organization was finally effected in March, 1851, by the passage of an act establishing the county from parts of Lewis, Barbour, and Randolph counties. It was named in honor of Abel P. Upshur, a prominent resident of lower Virginia and a member of the Cabinet during President Tyler's administration.

CLIMATE.

The climate of Upshur County is healthful and the waters of the area are pure. Neither the summer nor the winter seasons are subject to extremes of temperature. The rainfall is abundant and well distributed throughout the year. The spring is likely to be wet, and while this hinders planting somewhat, it is favorable to the grazing industry. The area of high altitude in the southern part of the county receives frequent showers during the summer season.

The average date of occurrence of the last killing frost in spring is April 26, and of the first in fall is October 7. The records of the Weather Bureau at Buckhannon and other neighboring points have been kept for but a short period and are not complete, so that no normals for either temperature or precipitation can be given. A table follows, showing two years records at Philippi, which is situated about 20 miles northeast of Buckhannon, at a somewhat lower elevation.

Monthly and annual temperature and precipitation.

Month.	1903.		1904.		Month.	1903.		1904.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	°F.	*Inches.*		°F.	*Inches.*	°F.	*Inches.*
January	32.4	4.72	27.6	3.11	August	70.2	2.40	69.8	2.79
February	33.1	5.86	29.6	2.12	September	63.4	2.29	65.8	2.82
March	50.2	5.36	44.4	4.03	October	52.8	3.00	51.0	1.74
April	51.7	4.24	47.0	2.37	November	37.2	3.41	39.0	0.46
May	63.8	3.92	61.0	2.47	December	25.1	2.49	31.6	4.29
June	64.8	5.03	68.6	5.71	Year	51.3	46.46	50.5	35.52
July	71.2	3.74	70.4	3.61					

PHYSIOGRAPHY AND GEOLOGY.

There are three physiographic divisions of the Appalachian province, consisting of the great system of mountains on the east, the central valley, and the Cumberland plateau. This plateau is formed of sedimentary rocks in nearly horizontal strata, which were laid down in a great interior sea. They have since been elevated and greatly dissected by stream agencies, so that little semblance of their former level, continuous character remains.

Upshur County lies wholly within this dissected plateau, and its topography is characteristic of the division. There is no portion of the county that is not hilly and much of it is rough and broken, while the southeastern and southern parts can be called mountainous. In the northern part the tops of the hills are from 1,600 to 1,800 feet above sea level and the valley floors from 1,100 to 1,400. The elevation gradually increases until in the southern part the hills are from 2,500 to 3,000 feet and valleys about 2,000 feet above sea level. The general dip of the rock is slightly to the northwest. The maximum thickness of these sedimentary rocks is about 4,800 feet.

Most of the drainage of the county is northward through the Buckhannon and Middle Fork rivers and their tributaries. The southwest corner belongs to the Kanawah system, and a small area in the northwest drains into the Monongahela. Small streams are numerous, with many branches which reach back into the hills and usually start abruptly from a widened gorge.

As classified in the Buckhannon folio of the United States Geological Survey, the surface exposures of Upshur County belong entirely to the Carboniferous period, which is represented by three different formations. They are known as the Pugh, Upshur sandstone, and Braxton, and belong to groups designated, respectively, as Lower Coal Measures, Lower Barren Measures, and Upper Coal Measures.

The process of erosion has been rapid in the area, so that only a comparatively thin mantle of soil has been allowed to collect over the rock surfaces, especially in the southern part of the county. Carved as they are from nearly horizontal strata of unequal hardness, the valleys present a somewhat uneven surface along their sides. This proximity of bed rock and the position of its strata in relation to the plane of the surface makes the presence of a stony loam type over a large part of the area a certainty.

The Pugh formation consists of dark-colored shales and brown sandstones and is found to a limited extent in the high southeastern part of the county. The soil type derived from it is chiefly the Dekalb stony loam.

The Upshur sandstone comprises the greater portion of the middle, eastern, and southern parts of the county. It consists of fine and coarse gray, brown, or yellowish sandstones, with occasionally some conglomerate, and is interbedded with layers of soft shales. The hillsides are steep and often precipitous, being held up by the hard sandstones which often jut out in a continuous line for long distances along a valley side, scattering the slope below the outcrop with great gray blocks and smaller fragments. The valleys are from 300 to 500 feet deep, and the streams are still cutting their channels deeper.

The disintegration of this formation has given rise to three types of soil. The Dekalb stony loam occurs where the clay shales and finer sandstones predominate, while the Rough stony land is found where the coarser sandstone has given the interstitial material a more or less sandy character, and, at the same time, has strewn a large number of bowlders over the soil. The tops of the hills in this formation are frequently of considerable extent, and nearly flat and free from stones. A majority of these areas have been classed as Dekalb loam.

The Braxton formation is found in the northern and northwestern parts of the county, and consists of yellow, green, and red shales, with a few layers of brown sandstone. The greater portion of it has weathered into the Dekalb clay. Most of the hillsides are steep, though many well-rounded slopes are in evidence. Many of the ridges are narrow and long. The streams of this section usually have a narrow strip of bottom land along them. From the green and red shales another type—the Upshur clay—has been derived.

The coal of the area has been practically unexploited as yet, though it is mined locally and for shipment in one or two cases. Practically the whole area is covered with coal seams of some description, many of them valuable and others of lower grade. A few small gas wells have been found, but no oil. The sand from a part of the Upshur sandstone is of excellent quality for glass manufacture, and the stone is crushed and used extensively for this purpose.

SOILS.

Six distinct types of soil are found in Upshur County. The area of each of these is given in the following table, while their distribution is shown by color in the map accompanying this report:

Areas of different soils.

Soil.	Acres.	Per cent.
Dekalb stony loam	82,560	39.1
Rough stony land	48,512	22.9
Dekalb clay	40,768	19.3
Dekalb loam	14,912	7.0
Upshur clay	13,504	6.4
Meadow	11,008	5.3
Total	211,264	

DEKALB LOAM.

The Dekalb loam is very similar in appearance and general character to the Dekalb clay, but it occupies a different topography and is lighter, both in texture and color. For 9 inches it is a yellowish loam, having a brown surface. The subsoil, to a depth of 3 feet or more, is a pale-yellow clay, or occasionally clay loam. Locally the soil contains considerable fine sand, and, in some sections, has a silty nature for a few inches. Fragments of sandstone are frequently found scattered over the areas. The soil often rests directly upon a bed of sandstone within 4 or 5 feet of the surface.

The Dekalb loam is found in the central-eastern and southern parts of the county in connection with the Dekalb stony loam. The type occupies the rather flat tops of nearly all the hills and ridges in the sections where it is found, and the extent and form of each individual area is dependent upon the size and slope of the hill. In most cases its topography is very gently rolling and the drainage rapid, though not sufficiently so to do much damage through erosion.

The Dekalb loam is derived directly by weathering from fine-grained sandstone or sandy shales, which underlie it in nearly a horizontal position. In this latter respect the soil differs from the other types of the area. Most of the areas come from the Upshur sandstone formation, though in the central part of the county the Braxton caps many of the hills. The distinction between the Dekalb loam and Dekalb clay is frequently not very decided along the general boundary between the two types, but it becomes very evident upon the hills farther to the southward.

The area upon which the larger part of the town of Buckhannon is situated is found at a much lower level than the greater part of this soil, and is derived from a layer of sandstone which was formerly exposed by the cutting action of the river. It has weathered into a few inches of gray, rather silty loam, which changes into a yellow loam, and finally becomes a yellow clay at about 10 inches from the surface. This soil area is free from rock fragments.

Naturally the Dekalb loam is not a very fertile soil, a fact indicated by its lighter color and the low content of organic matter. Its texture, however, makes its responsive, and it is capable of being brought to a satisfactory state of productivity if given proper attention. It should receive barnyard manure and some form of green manure whenever possible. Many of the areas in the southern part of the county are still in chestnut, oak, and poplar forest.

One drawback to the successful cultivation of a large number of these soil areas lies in the fact of their isolation. Long distances over rough, hilly roads usually separate them from the railroad, and there is little effort made to grow marketable products. Hay, corn, oats, and potatoes, with occasionally a little wheat, are the usual crops. It is the best potato soil in the area and produces tubers of excellent quality, as well as satisfactory yields. During dry weather the crops upon this soil suffer some from lack of moisture, owing to the high, exposed position of the soil and its proximity to bed rock. Corn produces about 25 bushels and oats from 20 to 25 bushels per acre. Wheat will not average more than 10 bushels per acre. All kinds of fruits do well. The areas of this soil are practically the only ones in the rougher parts of the county upon which hay may be grown satisfactorily.

The following table gives the average results of mechanical analyses of typical samples of the fine earth of the soil and subsoil of the Dekalb loam:

Mechanical analyses of Dekalb loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13337, 13339	Soil	0.4	1.9	3.1	15.8	10.4	46.2	21.8
13338, 13340	Subsoil	1.2	3.4	4.2	14.2	9.7	38.8	28.3

MEADOW.

The areas classified as Meadow consist entirely of bottom lands along the streams and occur principally in the northern part of the county. The streams in this section have cut more nearly to their base level of erosion than have most of those of the remainder of the county, and their force is now spent in widening rather than deepening their channels. For this reason more or less sediment is found along these stream courses.

The largest continuous areas are found along Fink and Turkey runs, Brushy Fork, and the Buckhannon River. Because of the variable character of these bottoms and the comparatively small areas occupied by them it was not found practicable to separate them into distinct types. A few areas are one-fourth of a mile wide, but the majority are less than one-eighth of a mile in width for the greater part of their extent. The lands are somewhat low and sometimes boggy, but with a few exceptions are not subject to periodic overflow.

While these bottoms vary greatly, even in a single field, and it was not practicable to separate the different soils, there are three classes which can be generally described. These depend somewhat upon the character of the country from which the stream issues, and also upon the type of soil occupying the immediate surrounding hills.

The first of these and the most valuable consists of a heavy brown loam for 8 or 10 inches, which is underlain by a yellow or dark-colored clay loam or clay. This phase is seen about Buckhannon "Island" and at other points along the river and other streams. Its position is higher than the average Meadow area, and it produces excellent yields of hay, corn, and oats.

The lowest and heaviest part of the Meadow consists of 10 inches of gray silty loam, underlain by a heavy, plastic, drab clay. These areas are quite extensive. As a rule they are too wet and soggy for corn, and hay forms the sole crop.

Sandy areas of Meadow occur at different points along the streams, and especially along Middle Fork, Kanawha River, the upper part of Buckhannon River, and the larger creeks. This phase varies from a fine sandy loam to a medium yellowish sand. The areas are usually under cultivation and give fair yields of corn and potatoes.

As a whole the Meadow lands are the most valuable in the county, since it is from them that the greater part of the hay is cut. They are left in grass permanently and yield from 1 ton to 1¼ tons of hay per acre. Some of the higher and more loamy portions are occasionally planted to corn and yield in good seasons from 40 to 50 bushels per acre. There is a tendency for the grasses to deteriorate and become coarse in the lower portions of the fields. This has been remedied by ditching in some cases, but there are still many areas which would be greatly benefited by this treatment. The application of lime as a top dressing is also to be recommended.

ROUGH STONY LAND.

The areas of Rough stony land occur upon the steeper hillsides throughout the central, eastern, and southern parts of the county. The presence of the type is due to the fact that in the Upshur sandstone formations there are certain strata of a massive gray sandstone, from 5 to 20 feet thick, which run through all the hills in a nearly horizontal position, and project as ledges upon the sides of the valleys. Usually the slopes have but a single outcrop upon them, and its relative position upon the hillside is controlled by the elevation of the hill and the height to which the dip of the formation has caused that particular stratum to rise. Occasionally it crowns a hill, and again it may appear only near the bottom of the valley. Below the projecting ledge the hillside is almost invariably strewn with bowlders and rectangular blocks, sometimes from 20 to 50 feet in length. Many fragments and smaller bowlders are strewn over the soil and incorporated with it. In nearly every case the soil as mapped occurs below one of these ledges. Frequently many bowlders and stones have collected in the bottoms and along the lower slopes of narrow valleys, together with more or less wash sand, thus giving rise to a small strip of the soil along the streams.

The greater part of the interstitial material is derived by weathering from the finer-grained sandstones and shales which occur between the massive beds. For this reason it is much heavier than if derived from the gray sandstone alone, though the influence of the latter has been considerable.

Over the larger part of the Rough stony land even the possibility of profitable agriculture is very slight, although a few small areas are cleared and under cultivation and some are in pasture. The greater part still remains in forest or has been cut over and is covered with small second growth. The timber consists of chestnut, white oak, poplar, chestnut oak, and near the streams considerable hemlock. It is thought that by far the larger part of this soil should be allowed to reforest itself.

UPSHUR CLAY.

The soil of the Upshur clay is a stiff dark-red clay, 6 or 7 inches deep. This passes into a red clay subsoil of similar character but lighter in color. Occasionally it has nearly a pink shade and also contains small bands of partially disintegrated greenish or yellowish shales. The soil in some cases is somewhat loamy and in others there is practically no textural difference between soil and subsoil. Locally it is scattered with a few sandstone fragments. The heavier portions bake hard and crack during dry weather. It is called "red clay" or "mulatto soil."

With the exception of Meadow this type is the least extensive soil in the area. It occurs principally in the northwest corner of the county in connection with the Dekalb clay, and on the whole is not especially important agriculturally.

Nearly all the areas of the Upshur clay are found upon very steep hillsides, frequently occupying the steep, amphitheaterlike rim about stream heads, or occurring in a strip along valley sides well up toward the top of the hill. Occasionally it crosses the hill through a low divide and extends into the valley on the other side. It suffers much from erosion. Possibly one-third or more is unfit for agricultural purposes because of its steep-gullied slopes.

The Upshur clay is a direct product of the weathering of the green and red shales that underlie it. In themselves they are comparatively soft and friable and disintegrate quickly when exposed. In many cases where the soil occurs, a protecting cap of harder shales, and more often sandstone, is found upon the crown of the hill. This feature has been largely responsible for the steep character of the type, since it has equalized erosion.

Most of the soil is kept in permanent pasture. This is so because of the difficulty in cultivating the steep hillsides and their tendency to wash, and also for the reason that the soil within itself is very tenacious and difficult to till. When found upon lower hill slopes or in a moderately rolling position it is likely to be much more loamy and is very productive for wheat and corn, as well as being a good grass soil. Much of it has been nearly ruined by excessive cropping to corn and other crops when first cleared. Wheat will yield about 18 bushels per acre and corn from 35 to 50 bushels per acre if given proper attention and some fertilizer.

The following table shows the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Upshur clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13319, 12828	Soil	1.3	3.3	1.6	5.4	7.4	34.2	46.5
13320, 12829	Subsoil	.9	5.3	2.8	5.7	4.5	28.6	52.1

DEKALB CLAY.

For the first 2 or 3 inches the soil of the Dekalb clay is usually a brown and occasionally a gray loam. Thence to a depth of 10 inches it is a yellowish clay loam, at which point it grades into a dark yellow clay, which continues to a depth of 3 feet or more. There is no distinct line of division between the soil and subsoil. Fine pieces of yellowish shale and fragments of sandstone are usually scattered through it, sometimes in considerable quantities, thus making the soil appear somewhat coarser in texture and more open in structure than an analysis of the fine earth shows. A phase having a more loamy and deeper soil is common in limited areas, especially in small coves and upon lower hill slopes. The soil on the hilltops is also somewhat lighter in texture, but such areas are of small extent. Areas of Upshur clay too small to be represented upon the map are numerous in some localities. The soil rests upon a mass of broken shale, which is sometimes within 3 or 4 feet of the surface, but usually considerably deeper. Outcrops of this shale are common and give rise to small areas designated locally as "slaty land."

The type covers the larger part of the county north of Buckhannon and also extends down its western edge several miles. The section comprises the best agricultural lands of the county and covers from one-fourth to one-third of its area.

The usual topography of the areas occupied by the type is hilly and sometimes rough. In some cases characteristic well-rounded shale hills occur and along the larger streams the slopes of the hills are oftentimes gentle, but upon the whole the type occupies steep slopes. In many cases the hills converge to a sharp peak, and the tops of the divides are but a rod or so wide. The roadways follow the streams and where the streams end wind to the top of the ridge only to descend immediately into the next valley.

Such being its position, the Dekalb clay is likely to suffer more from excessive drainage and destructive erosion than some of the other types of the county. However, the presence of deep gullies upon the hillsides is not a prominent feature of the soil.

The Dekalb clay is largely a residual soil, derived directly from the underlying yellowish clay shales by the process of weathering. These shales contain thin strata of sandstone, and it is from this source that the rock fragments come. The gentle slopes have received and retained some of the wash from the upper hillsides, and to this extent they are partly colluvial in origin.

Examination has shown that these shales are somewhat calcareous in local areas, thus exerting an influence which makes the type more nearly akin to a limestone soil in natural productiveness. The application of lime as a top dressing to the heavier parts of the soil has been found beneficial, but it should not be used upon slaty portions or the higher areas subject to drought.

The proportion of the type kept in pasture is from 85 to 90 per cent. Wheat, corn, and oats are the chief cultivated crops. Wheat yields from 10 to 12 bushels, corn from 20 to 30 bushels, and oats from 20 to 25 bushels per acre. Wheat often produces a good yield of straw, but does not head well.

The following table gives the average results of mechanical analyses of the fine earth of the soil and subsoil of the Dekalb clay:

Mechanical analyses of Dekalb clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12826, 13329, 13331.	Soil	0.8	2.0	0.9	4.3	7.9	49.4	34.4
12827, 13330, 13332.	Subsoil.....	1.6	3.2	1.3	4.8	8.0	43.6	37.4

DEKALB STONY LOAM.

The Dekalb stony loam consists of from 8 to 10 inches of brown or yellowish loam, underlain by a yellow clay loam or clay subsoil that becomes heavier as the depth increases. Scattered over and through the soil are sandstone fragments and some shale, besides bowlders of various sizes. In all cases the amount of rock débris is sufficient to interfere seriously with cultivation. The texture of the soil varies considerably. The small areas found in the northern part of the county are usually heavier in texture and are covered with less rock than the main portion of the type. In some cases the loam covering contains a greater proportion of fine sand than in the typical soil, owing to the large number of sandstone fragments scattered through it. The value of the type, however, depends more upon the character of the surface and steepness of the slope than upon its texture. In many cases, if trouble be taken to remove the stones, a fairly open field can be secured. But over a considerable area, especially in the southern part of the county, the ground is so completely covered and filled with rock as to make cultivation impossible, and the areas are worthless, except for a limited extent of pasture and possibly some fruit growing. The natural growth is chestnut, chestnut oak, white oak, beech, and poplar.

The Dekalb stony loam is the most extensive soil in the area and occupies the larger part of the county east of the Buckhannon River, besides large areas to the west of that stream in the southern and central parts.

The main area of the type occupies steep hillsides and mountain sides. In some cases it extends over the rounded hilltops, and in the northern part of the county it occasionally caps a ridge or hill. It is always well drained and is apt to suffer considerably from washing.

Yellowish clay shales and very fine grained brown sandstone of the Upshur formation make up the larger part of the rock from which this soil is derived. These occur in alternate layers of varying thickness, and the predominance of one or the other seems to have little influence in changing the texture of the soil. This is in part due to the fact that the soil is formed mostly upon steep hillsides, and the process of weathering, assisted by gravity, has served to mix the products from the two classes of rocks. The larger shale areas, however, usually have a deeper soil and carry a less quantity of rock fragments, so that they are more valuable from an agricultural standpoint. A gray, coarse-grained sandstone is also a prominent feature of the Upshur formation in some localities. To a certain extent the disintegration from this rock has influenced the texture of the soil, but by far the greater influence has been exerted by the direct incorporation of gray sandstone fragments with the soil and the scattering of rocks and bowlders over the surface. As far as texture of soil and natural fertility is concerned the Dekalb stony loam is well adapted to the growth of all crops suited to the area. Its cultivation and practical agricultural value, however, are greatly limited by the steepness of the slope which much of it occupies, and also by the excess of rock on the surface. In the southern part of the county only a very small percentage of it has been cleared and the most of that is devoted to pasture. Some corn, oats, and wheat are grown, and a little hay. Grain must be sown as well as harvested by hand and the yields are small. Corn upon the best areas will yield from 20 to 25 bushels per acre. The larger part of this soil is best adapted to pasturage, but small areas of other crops should not be neglected. Much may be done in the way of removing the stone from the fields. It is believed that sheep grazing would be fully as profitable as that of cattle. Apple orchards of standard varieties would do well, especially upon the north and east hill slopes, and grapes would probably be a success. The land is valued at from $7 to $12 an acre.

The following table shows the average results of mechanical analyses of the fine earth of samples of the soil and subsoil of the Dekalb stony loam:

Mechanical analyses of Dekalb stony loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12919, 13323, 13002..	Soil	1.1	13.5	7.5	10.0	4.6	31.9	31.0
12920, 13324, 13003..	Subsoil...	1.0	10.8	6.7	10.9	4.9	28.6	36.8

AGRICULTURAL METHODS.

The agricultural methods employed in Upshur County are those common to that section of the State, and have developed naturally through a long period of practice. There have been few, if any, important changes in them during the past fifteen or twenty years. The general system of farming in use is probably the best for the area, though in some particulars changes would be beneficial. This discussion of methods applies largely to the northern or so-called lower half of the county, since in the southern half little development has taken place and agriculture is as yet of secondary importance.

Stock raising is the most important industry of the county, and the great part of the land is in permanent pasture. Shortly after being cleared many of the fields were planted year after year to corn or some other crop, with little or no thought of rotation and with no fertilization of any kind. As a result, after a number of years the impoverished fields failed to produce satisfactory yields and many of them were badly washed and gullied. It is still the custom in the southern part of the area to plant corn upon newly cleared land "for as many years as it will stand it." Over much of the county the land is spoken of as "worn-out." Formerly much of it produced corn at the rate of from 35 to 50 bushels per acre, and yields of from 18 to 20 bushels of wheat per acre were not uncommon.

From this heavy cropping a reaction took place, and at the present time there is a tendency for farmers to allow almost their whole farms to remain in permanent pasture, to the exclusion of even small quantities of other crops except hay. While stock raising should undoubtedly be the primary feature of the agriculture of the county, it is thought that too little attention is given to other crops even for the benefit of the pastures themselves. Many are overrun with ragweed and cinquefoil. It is true that these weeds seem to appear sooner in newly seeded land, and are more persistent than formerly, but in many cases the fields are left without attention for too long a period. It is important that the steeper hillsides be covered with sod for the greater part of the time, but a system of rotation should be devised which will demand the plowing of these when the grass runs out. Organic matter should be incorporated with the soil at every opportunity. Some farmers employ a rotation consisting of corn, oats, and grass for three years. Bluegrass comes in naturally and forms a good sod, especially upon the heavier clay soil. The sod should be retained as long as practicable, but not after it has run down, as is often the case.

The damage from washing upon the hillsides is sometimes considerable, but it is believed that this danger has been overestimated, provided proper care is used in handling the field. A back furrow or small strip of unplowed land left along a hillside will often serve to prevent considerable damage. Little clover is at present grown in any part of the area, and its value as a soil renovator is not generally recognized. Its growth simply as a crop would be beneficial to most of the soils of the area, and if plowed under as a green manure the benefit would be greatly increased. Alfalfa has been successfully grown on the Dekalb clay.

The use of commercial fertilizer in growing corn and oats is becoming quite general and results seem to warrant its use, at least in limited quantities. Little barnyard manure is employed, for the reason that stock in a large majority of cases is not housed even during the winter months. Hay is put up in small stacks in the field and the cattle fed directly from them. Shelter for stock in a climate as severe as that of Upshur County should be the rule rather than the exception, and the present practice should be condemned. The saving of feed would pay for shelters within a few years, and, in addition, a stock of manure would be accumulated, which could then be applied to portions of the farm which especially needed it. The small stock of manure from the horse stables is all applied to the gardens, and they receive the best of care and attention, furnishing a plentiful supply of excellent vegetables through the season. The excellence of the farm gardens is one of the special features of the area and contributes in no small degree to the healthfulness of the people.

The stock raised is usually of good grade, and consists of the Shorthorn, Polled Angus, or Hereford breeds. The calves are either raised or purchased in the county, and are marketed either as 3 or 4 year old steers. The selling age depends partly upon the conditions of the stock and partly upon the feed supply of each individual owner.

The comparatively small area of suitable and naturally productive hay lands in the county makes it important that these be made to yield the largest possible crops. At the present time many of the meadows are poorly drained and are not giving the best returns. Not only is the quantity of the product below the average, but the quality is also poor. Practical proof of the value of drainage is in evidence in certain places, and the use of tile drains for the wet areas is recommended. Not only will it be possible to grow larger yields of hay upon the drained areas, but in some cases the lands will be made suitable for other crops as well.

There are at present but few large apple orchards in the county, and these are given little attention. Many of the rougher parts of the area, especially the north and east hillsides, would be suitable for the growth of apples.

The ideal farm in Upshur County consists of a certain area of bottom meadow land for the production of hay, besides the hill land for pasturage and for cultivated crops. It is this combination which has contributed much toward the prosperity of many of the farmers along the principal creeks and runs in the northern part of the county.

AGRICULTURAL CONDITIONS.

The prosperity of the farming class in Upshur County is somewhat varied. As has been pointed out already in this report, the northern and northwestern sections of the county have superior soil conditions, and in these it is but natural to find agriculture best developed and its people in the most prosperous condition. Here the farm dwellings are usually neat and well kept, although there are comparatively few outbuildings.

Southward from Buckhannon, as the country becomes more rugged, successful agriculture decreases. The farms become rougher and more infrequent and farm buildings less pretentious, and in the southern part of the county there is little attempt to rely entirely upon agriculture for a livelihood, and the hauling of tanbark, or various occupations connected with lumbering, give employment to a majority of the population for at least a part of the year.

One reason for at least temporary prosperity over a large part of the area, both in the best agricultural sections and also in the rougher parts, is the fact that a large number of coal rights have recently been sold. They were purchased at from $10 to $12 an acre.

At least 90 per cent of the farms in the county are operated directly by their owners. This feature has resulted in a majority of the farms being well kept and usually well fenced. When renting is done it is usually upon a cash basis, and the price varies greatly, according to the location and desirability of the holding. Instances were noted in the southern part of the county where the consideration for rent consisted simply of the payment of taxes and the keeping up of the fences.

The size of the farms ranges from 50 to 150 acres, the average being somewhat under 100 acres. Large holdings are few, except in the undeveloped southern part of the county, where several thousand acres of wild land are frequently held either by individuals or stock companies. Each farm usually has a few acres of woodlot upon it. This is not necessary for fuel, since that need is supplied by the abundance of bituminous coal outcropping upon a large proportion of the farms. Coal is sold locally for 3 cents a bushel. Of the total area of the county about 60 per cent is in improved farms, though in the northern part the proportion of improved land is much greater, probably ranging between 90 and 95 per cent. The estimated value of farm lands varies greatly in different parts of the county, and there is little changing hands at present. In the rougher portion from $8 to $12 an acre would be an average price for partially improved land. In the better sections farms are held at from $20 to $35 an acre, and in some few favored localities, as along Hackers Creek and Turkey Run, some farms are valued at from $50 to $75 an acre, but this is not usual.

In a country where stock raising is the chief industry little farm labor has to be hired, except for a limited time in summer, and the number of farmers who have hired help for more than a few weeks is small. The wages of farm labor are about $1.25 a day during harvest, and 75 cents a day at other times of the year. Usually there is no difficulty in securing labor. A large number of men are employed in the lumbering camps, in which wages of from $1.25 to $1.40 a day, with board in addition, are paid. A single team to do the hauling and cultivating is usually all the draft stock necessary upon even the larger farms.

Forest products and beef cattle form the two principal exports from the county. The value of the former is declining at the present time, and that of the latter is increasing somewhat. Sawed lumber and tanbark come from the upper part of the county, and Buckhannon is practically the only shipping point for farm products. The cattle are shipped to Baltimore, Philadelphia, and New York, and many are sold for live export. Small quantities of wool and a few sheep are also shipped. The products used either directly upon the farm or disposed of in Buckhannon consist of hay, wheat, oats, corn, buckwheat, apples, potatoes, and small fruits. The quantities of these products do not supply even the local market, and grain, hay, and potatoes are shipped in. Dairy products are not important, and there is no creamery within the county. Considerable poultry is raised, and some little truck produced in the vicinity of Buckhannon. Comparatively few hogs are sold in the local markets.

With a somewhat similar general character in all the upland soils of the county, there is little chance for special adaptation of crops to soils. However, in certain general ways, the value of such specialization has been recognized and practiced. Most of the areas mapped as Meadow are kept in permanent grass lands. Upon the loamy or sandy loam portions of the type excellent yields of corn and oats are obtained. It is recognized that, with the exception of the Dekalb loam, the majority of the soils should be kept under sod for a large part of the time to prevent destructive washing. This condition has brought about the existence of the grazing industry as the main feature of the agricultural system.

Upshur County lies somewhat off the main line of travel, and does not enjoy the advantages of a trunk-line railroad. A branch of the Baltimore and Ohio Railroad traverses the county in a north and south direction, and another short branch gives a second route from Buckhannon northward. The Coal and Coke Railroad has recently been completed across the middle part of the county from east to west, and will furnish an outlet toward the southern part of the State not previously afforded. The wagon roads of the area are usually poor. They are repaired occasionally, and for a few months during the summer are in good condition, but for the rest of the year they are full of ruts and holes. Considering the amount of good stone at hand and the very urgent need of at least a few stone pikes, the county is extremely backward in this important direction.

SOIL SURVEY OF LOUISA COUNTY, VIRGINIA.

By **HUGH H. BENNETT** and **W. E. McLENDON.**

LOCATION AND BOUNDARIES OF THE AREA.

Louisa County, situated near the center of Virginia and in the region between the head of tidewater and the Blue Ridge, is included within parallels 38° 10′ and 37° 40′ north latitude, and meridians 77° 40′ and 78° 20′ west longitude. It has a mean length from the Albemarle line on the west to the Hanover line on the east of 30 miles and a mean breadth of about 16 miles, embracing an area of 323,008 acres, or a little less than 505 square miles.

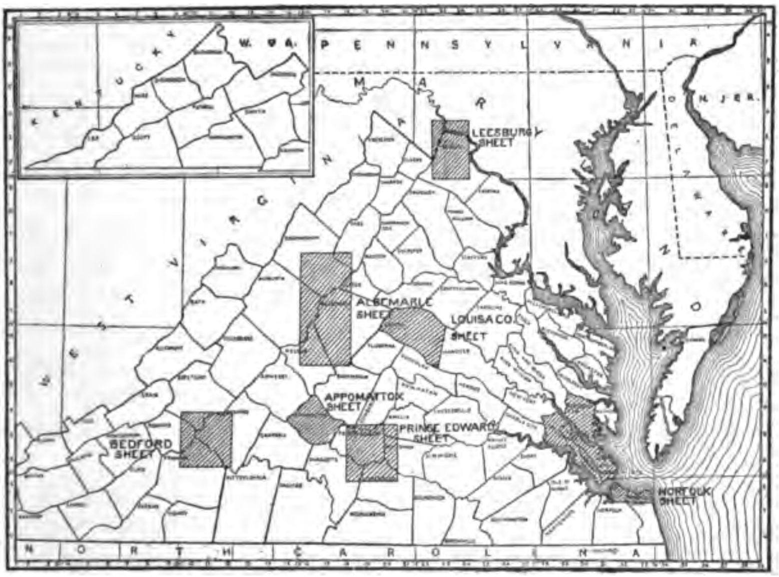

FIG. 6.—Sketch map showing location of the Louisa County area, Virginia.

Louisa, the county seat and largest town, is situated in the center of the county and is about 80 miles southwest of Washington and 45 miles northwest of Richmond. The South Anna River flows about 40 miles southwesterly through the county, parallel to and at an average distance of 4 miles from the southern boundary. The North Anna, flowing east and southeast, with Negro Run, constitutes the northern boundary. Fluvanna and Goochland counties touch the area on the south, Albemarle on the west, Spottsylvania and Orange border it on the north and northwest, respectively, and Hanover on the east.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Louisa County was cut off from Hanover and organized by an act of the colonial legislature in 1742. At the time there were farms on several important streams, and in this year roads were laid out, supervisors appointed, and tavern rates fixed. The area was settled by expansion of the earlier Virginia settlements and by immigrants directly from England. The population in the main has been always of English descent.

The agricultural practices were similar to those of the early settlers of East Virginia. The cultivation of tobacco, almost exclusively, was deemed at first an economic necessity. An abundance of virgin soil admirably adapted to tobacco, coupled with rapid decline in productiveness of the soil caused by continuous cultivation without rotation or manuring, soon led to a wasteful mode of agriculture. After the land had been cultivated for three years, when the soil was considered exhausted, new fields were cleared for cultivation. Happily the colonial legislature restricted the acreage of tobacco and required the cultivation of specific areas to other crops. Thus the early farmers, in addition to the growing of tobacco, became familiar with the cultivation of wheat, corn, oats, flax, and other crops. The live stock running at large, all breeds being indiscriminately mixed, and having but scant subsistence in winter, resulted in a scrubby stock that has not entirely disappeared.

Each plantation was a community within itself, with a distinct round of occupations. During the interval between the Revolutionary and civil wars the farms were practically self-sustaining. Plows, except the moldboard, and cloth of wool and cotton were made on the farm. Thus originated a kind of rural gentry—an independent class, the owners of plantations—who intrusted the details of farm management to overseers, a contingency that had to do, perhaps, with the little soil improvement of this period.

Very little attention had been paid to crop rotation until the latter part of the eighteenth century. In 1794 Thomas Jefferson described a rotation he had decided upon for the recuperation of his land in Albemarle County, a plan that was very similar to the present general scheme of crop succession. After that time a very beneficial crop rotation was gradually worked out. About 1850 the old practice of continuously cropping land until "worn out" and then taking in "new ground" had begun to lose favor. The practice of fallowing also had weakened. Deep plowing was recognized as beneficial and had become popular. Considerable quantities of "Peruvian guano" and plaster were used about this period, particularly in the "Green Springs Neighborhood."

The Chesapeake and Ohio Railroad, built about 1846, while it gave no sudden or great impetus to agriculture, was the cause of a rapid depletion of the merchantable timber of the county.

Lack of capital and disorganization of labor, which followed as a result of the civil war, necessitated the abandonment of large areas of cleared land that since have grown up in old field pine.

In 1855, as a basis of taxation, land was valued at about $8 an acre for the county; but little was for sale.

CLIMATE.

The following tables, compiled from the records of the Weather Bureau, show the normal monthly and annual temperature and precipitation, and the dates of first and last killing frosts, as recorded at Barboursville, 5 miles west, and Ashland, 18 miles east of the area, and represent approximately the climatic conditions of the area:

Normal monthly and annual temperature and precipitation.

Month.	Barboursville.		Ashland.		Month.	Barboursville.		Ashland.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	*°F.*	*Inches.*		*°F.*	*Inches.*	*°F.*	*Inches.*
January	37.5	3.63	36.0	2.85	August	75.5	4.33	76.0	3.92
February	35.1	4.16	36.5	3.48	September	70.9	3.40	69.5	5.15
March	47.6	3.70	48.2	3.41	October	59.2	3.06	57.8	3.84
April	54.5	3.38	56.0	3.67	November	48.6	2.53	48.0	2.49
May	65.4	4.83	66.1	4.78	December	37.5	3.41	38.9	2.97
June	71.9	5.62	73.0	3.53					
July	77.4	4.04	78.0	4.72	Year	56.8	46.09	57.0	44.81

Dates of first and last killing frosts.

Year.	Barboursville.		Ashland.		Year.	Barboursville.		Ashland.	
	Last in spring.	First in fall.	Last in spring.	First in fall.		Last in spring.	First in fall.	Last in spring.	First in fall.
1897	Apr. 21	Oct. 31	Apr. 21	Oct. 31	1902	Mar. 26	Oct. 15	Apr. 14	Oct. 15
1898	May 9	....	Apr. 7	Oct. 24	1903	Apr. 5	Oct. 27	Apr. 6	Oct. 19
1899	Apr. 17	Oct. 1	May 17	Oct. 6	1904	Apr. 22	Oct. 16	Apr. 22	Oct. 16
1900	May 10	Oct. 18	Apr. 10	Nov. 10					
1901	Mar. 18	Oct. 26	Mar. 29	Oct. 26	Average.	Apr. 16	Oct. 19	Apr. 16	Oct. 22

The climate is markedly uniform and favorable both to health and agriculture. The range of temperature between normals for February and July, the coldest and the warmest months, respectively, is about 42° F., while the absolute maximum range is about 113° F. The ground in exceptional cases freezes about 15 inches deep, the normal range being from 2 to 7 inches. The heaving of heavy soils frequently damages wheat by lifting it out of the ground, and young clover is winter-killed badly where sown late, damage from this cause being more prevalent on the lighter-colored soils. Alternate cold and warm spells in early spring make some of the early blooming fruits, as the peach, problematical crops. Rainfall is heaviest during the growing season. The least precipitation occurs in the fall, which is quite favorable to tobacco curing. Heavy dews, which begin to appear the latter part of August, are said to be beneficial for maturing tobacco, especially in the thickening of filler leaf.

PHYSIOGRAPHY AND GEOLOGY.

Louisa County, as seen from the Southwest Mountains, which rise almost abruptly to an elevation of 1,100 feet just west of the county line, has the appearance of a plain. There are no pronounced elevations above the general upland level, a characteristic of the eastern part of the Piedmont, known as "Middle Virginia" and roughly included between a line passing through nearly the center of Fairfax County in a southwesterly direction to the North Carolina line, and the low, broken range of mountains which parallel the Blue Ridge, distant about 20 miles farther west.

The western half of the county, beginning at Louisa, is essentially a plain with an altitude of 500 feet above sea level. East of the town of Louisa the general surface slopes gradually toward the eastern boundary, where the altitude is about 300 feet. The greatest altitudes are reached in a ridge crossing the county in a southeasterly direction from Gordonsville through Bumpass, and in a similar parallel ridge along the southern boundary of the county. Along these drainage divides rise many streams that flow almost at right angles into the North Anna and South Anna rivers, draining, respectively, the northern and southern parts of the area. There is a gradual, although almost imperceptible, slope toward these rivers. Stream erosion has produced a decided disfiguration of the once more level surface. Beds of streams, merely spring branches along the divides, deepen rapidly as they near the rivers, where the valleys are from 150 to 250 feet deep. Thus have been formed many secondary ridges or drainage divides, the slopes of which become more abrupt toward the rivers and at the confluence of smaller streams. In general the surface features consist of an intricate system of valley slopes and rounded ridges. The river valley slopes are generally gentle enough to prevent excessive erosion, though the surface soil has been shallowed and in places removed, thus leaving the subsoil clays exposed.

On the whole, there has not been the excessive washing and deep gullying characteristic of the Piedmont, a condition in part the result of the extensive forested areas, which liberate the heavier rains much more gradually than otherwise would be the case.

In the southeastern part of the county the creeks and smaller streams have a tendency to flow easterly and diagonally into Little and South Anna rivers, and the surface is more gently rolling, but even here it is deeply cut by small streams. Along Negro Run, the northwest boundary of the county, there are fewer streams, and consequently the surface is less broken. Owing to a failure to keep the lower courses of many of the streams open, coupled with a neglect of the adjacent slope soils, streams are building up and broadening their flood plains, and as a result considerable areas of former good cultivable lands are now in a marshy, untillable condition.

The rivers are meandering in their courses and are generally bordered by strips of bottomland, which occurs most extensively in the concaves of bends and is frequently interrupted by precipitous bluffs. The smaller streams also have narrow strips of wet lands along their courses.

Geologically the area consists of a well-defined series of igneous and highly metamorphosed rocks of the same era, crossing the county in a general northeast and southwest direction in almost uninterrupted parallel belts. The dominant rocks bear directly upon the character and properties of the overlying soils, while the few unimportant rock variations have no influence on them further than to cause local and slight nonconformities.

The eastern third of the county is underlain by a hard, banded gneiss, composed in the main of feldspar, quartz, hornblende, and mica. The apparent durability of this rock, suggested by its toughness in outcrops along streams, is contradicted by the depth and uniformity of its weathering, there being very few surface outcrops and only occasional fragments at a depth of less than 10 to 30 feet.

Immediately west of the gneiss area the county is crossed by a belt of talcose schist of a brownish or gray color and very soft. In many of the road cuts the unweathered rock is exposed; but on the whole the weathering extends to 10 or 20 feet below the surface. The average width of this belt is about 4 miles. These schists are traversed in all directions by many quartz veins, some of which carry minute quantities of gold, while along Contrary Creek are some of the largest iron-pyrites mines in the country.

North of Louisa is a wedge-shaped area of granite reaching a maximum width of 8 miles along the North Anna River and narrowing down to about 1 mile just south of Louisa, which width it retains in a strip extending beyond the southern edge of the county. This granite is of a coarse-grained porphyritic variety, high in quartz and feldspar. It weathers readily, though not deeply, and has a tendency to hold its original structure even when thoroughly decomposed, a characteristic probably due to a kind of clinging skeleton of the constituent quartz. Occasional orbiculate granite bowlders are found on the surface. Other areas of granite are found in what is known as the "Green Springs Neighborhood," 10 miles west of Louisa. Here the range in the rocks is from a very highly siliceous granite, with very little mica and hornblende, to a dark heavy hornblende granite, which gives rise to the heaviest soils in the county. The more siliceous areas give rise to the Cecil sand, a large area of which occurs just north of Lasley. The heavy red clay areas south of Lasley seem to be derived from a very compact, fine-grained hornblende granite.

The remainder of the western half of the county is underlain by a talcose schist about the same as that previously described, except along the western boundary, where is found a hard slatelike variety in which the quartz assumes a flinty character. Going west the depth of weathering diminishes and the magnesian silicate content increases. Throughout the overlying soil mass, particularly on ridges, are scattering quartz fragments and outcrops of quartz veins still partially intact.

SOILS.

The different types of soils have distinct and easily-determined boundaries, with the exception of the Cecil fine sandy loam, the sand of which frequently is so fine as to make the type resemble the Cecil loam. All the types, except the Iredell clay loam, have nonconformities, in the shape of small poorly-drained areas about the heads of streams, such places being locally designated as "crawfish land."

The soils of the area differ from the general run of Piedmont soils in the low percentage of rock fragments and in the extreme poverty of their organic content. Another distinguishing feature is the unhealthiness of the soils, a condition evidenced by the prevalence of clover sickness and by the marked beneficial results of liming. The subsoils are generally distinctly acid to litmus paper.

During periods of drought the cultivated soils are apt to assume a whitish, bleached appearance. They are put into good tilth easily, but their tendency when wet is to revert to a close, compact structure.

Seven types were recognized and mapped. Their names and extent are shown in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Cecil sandy loam	150,400	46.4	Cecil sand	8,192	2.6
Cecil loam	108,992	33.8	Cecil clay	7,168	2.2
Cecil fine sandy loam	26,432	8.2	Total	323,008	
Meadow	11,520	3.6			
Iredell clay loam	10,304	3.2			

IREDELL CLAY LOAM.

The soil of Iredell clay loam consists of a dark-brown loam, frequently having almost the texture of a sandy loam, and grading at about 7 inches into a yellowish clay loam. The depth of soil varies from 6 to 16 inches, the average depth being about 9 inches.

The subsoil consists of a yellowish heavy clay, often grading into disintegrated rock at a depth of 26 inches. The subsoil of more nearly level areas, reached at a depth of 6 to 8 inches, is to 36 inches extremely heavy and impervious to water and air. Many small iron concretions are mingled with the soil on poorly-drained springy slopes. Occasionally the soil covering of slopes has been washed off, leaving exposed the subsoil, so as to preclude cultivation except for grass.

Practically all of the type is confined to a nearly oval-shaped area along the South Anna River, 8 miles west of Louisa. Several lesser detached areas lie to the southeast of the main body.

The type is more nearly level than adjacent soils and occupies a slight depression. As a whole it presents a gently undulating topography. The South Anna River, with several small tributaries, affords a good drainage system. Between the small streams are flat table-land areas, poorly drained and extremely heavy, locally called "slash land." Along the streams the soil is very fertile, being composed of a heterogeneous mixture of the type and material washed down from surrounding types.

Very little open ditch or tile drainage has been practiced. The latter system would be the only feasible plan for draining, and with the heavier phases the great number of drains necessary would entail an expense that might not be justified even by the resultant soil improvement.

The soil is formed by the weathering of a hard hornblendic granite. A close examination of this rock reveals, at the contact of its constituent feldspar and hornblende, serpentine as a probable alteration product of the hornblende. Weathering has been very uniform, but not deep, evidently because of the exclusion of air and water by the imperviousness of the overlying soil. Small veins of a quartz-feldspar granite cut through the main body of the parent rock, but have little effect on the soil beyond leaving a few rock fragments on the surface. This body of soil, known as the "Green Springs Neighborhood," was considered before the civil war one of the most fertile spots in Virginia. Considerable heavy shipping tobacco was produced before 1870, and yields of 1,000 pounds per acre were secured. A yield of 40 bushels of wheat per acre was secured on this land at intervals until about thirty years ago, since which time agriculture has declined, and now most of the type is sown to grass. Only very poor yields of wheat are secured. Some fair crops of corn are made.

Before the introduction of Peruvian guano, which was extensively used after 1850, the only fertilizers used were barnyard manure and plaster. Imported rock gypsum was ground in mills on the farm and applied as a top dressing to clover in the spring. Since the civil war commercial fertilizers have been about the only manures applied to the soil. A lack of labor and capital has had much to do with the decadence of agriculture.

The soil is decidedly acid to litmus and is benefited by lime and thorough cultivation.

As the type is now devoted mostly to grass, it would seem that the cattle industry might be extended with profit.

The following table gives the average results of mechanical analyses of the Iredell clay loam:

Mechanical analyses of Iredell clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
13534, 13536	Soil	4.0	7.8	3.8	10.6	9.8	43.7	20.8
13535, 13537	Subsoil	1.1	3.1	1.8	6.6	7.5	24.3	55.6

CECIL LOAM.

The Cecil loam, to a depth of 6 to 8 inches, consists of a yellowish-gray to brownish friable loam of a silty character. Below this occurs a gradation through a clay loam into a heavy red or yellow clay at an average depth of about 12 inches.

Below 18 to 26 inches the subsoil becomes more friable and has a greasy feel, and occasionally represents little else than an incoherent mass of soft, partially-decomposed rock. The red subsoil predominates and may be considered typical of the type.

Varying amounts of quartz fragments from the size of small gravel to 2 inches in diameter occur scattered over the surface and to a less extent through soil and subsoil, but rarely in sufficient quantities to interfere seriously with cultivation. The humus content of the soil is low, especially in older fields, where the soil has a tendency also to become more sandy on account of the finer material being removed by surface wash.

The Cecil loam is an easily-tilled soil and can be kept in excellent tilth if due attention is paid to moisture conditions. If plowed too wet, subsequent dry weather is apt to harden it into a rather refractory structure and cause it to clod badly with later cultivation. These clods differ from those of a true puddled soil in the comparative ease with which they disintegrate. Heavy rains form a crust 1 to 2 inches thick on the surface of the cultivated soil, which favors capillary loss of moisture if not broken up or mulched.

The loamy texture of the Cecil loam would indicate a productive soil, but like that encountered in other sections it is recognized as being naturally poor, though susceptible of improvement by judicious management.

The Cecil loam occupies the greater part of the county west of Louisa. About 3 miles east of Louisa is a very uniform belt, about 4 miles wide, crossing the area in a northeast and southwest direction. There are several detached areas closely associated with the Cecil fine sandy loam.

Many streams through the type flow into the North Anna and South Anna rivers. Thus have been formed a series of nearly parallel interstream ridges that have in turn been cut into by lesser streams, forming a secondary series of ridges. The slopes are usually rounded and are under cultivation to a much greater degree than the summits. Drainage is excellent, except in depressions and in small areas near stream courses.

The soil is residual in origin and is derived entirely from a talcose schist, having a soft to compact slaty structure, varying but slightly in composition. The magnesium-silicate content is probably higher, texture finer, structure more compact, and weathering shallower as the western boundary is approached. There are occasionally small areas near the Albemarle line, where resistant phases, containing from 5 to 20 per cent of flintlike quartz, have not weathered more than a foot or two below the surface. Quartz veins occurring through the entire area have left many small rock fragments on the surface. The parent rock has weathered generally uniformly to a depth of about 6 to 20 feet. Weathering has been particularly thorough on the higher ridges, where the soil seems more silty and the subsoil is redder and heavier.

Most of the upland is forested with a stunted growth of white, red, post, and chestnut oak, hickory, and old field pine. An original heavier growth of pine and oak has been removed. West of Greensprings Depot the type is termed "piney woods" land, though there is practically no pine left.

Of the crops grown on the Cecil loam tobacco receives most attention and makes the best comparative yields. Wheat does fairly well on the slopes, where the soil is heavier. Corn receives too little attention and the yields are very poor and uncertain. Clover catches poorly because of soil acidity, it is believed, and imperfect methods of seeding. Hay yields about one-half ton, corn 10 to 12 bushels, and tobacco 300 to 700 pounds per acre. Vegetables do well. Barnyard manure and cowpeas with lime give immediate and permanent benefit, as does plowing in the fall, especially where portions of the subsoil are turned to the surface. Subsoiling should be tried, and in general the plowing should be much deeper.

The crop yields obtained on the present small farms can not be taken as a just measurement of the real worth of this type of soil, inasmuch as they do not indicate the greatly increased yields to be had by small applications of lime and organic manures coupled with a better system of tillage.

Some careful attention is paid to crop rotation, but cowpeas should be included more frequently in the scheme of rotation.

The following table shows the average results of mechanical analyses of the fine earth of the Cecil loam.

Mechanical analyses of Cecil loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
13530, 13532	Soil	1.0	4.9	3.6	14.8	16.1	38.9	19.4
13531, 13533	Subsoil	1.1	2.4	1.6	6.6	7.7	21.4	58.9

The manurial requirements of this soil were studied, using a large sample collected from a field near Greensprings Depot. This field has been in cultivation for thirty years or more, being planted a larger part of the time to corn, wheat, or oats. For the three years preceding 1905 no crops were grown, but during the summer of this year (1905) the land was plowed to a depth of about 6 inches and sowed to cowpeas.

The results obtained from the examination by the wire-basket method indicate that this soil will respond to a remarkable degree to all forms of fertilizers which were tried. Excellent results were obtained from cowpeas and lime; from a combination of nitrate of soda, sulphate of potash, and acid phosphate, with lime; from the complete fertilizer alone; from nitrate of soda alone or in combination with sulphate of potash or acid phosphate; from lime alone, and from manure alone. Sulphate of potash alone gave good results, while acid phosphate alone or in combination with sulphate of potash gave medium results.

In these tests wheat plants were used as an indicator. To what extent the tests are applicable to tobacco, corn, and other crops of this region is subject for further investigation. They are held also to be applicable only to the field from which the sample was taken. They are in accord, however, with the experience and practice of the community, and show the great value of lime and any nitrogen-producing fertilizer.

CECIL SANDY LOAM.

The soil of the Cecil sandy loam consists of a gray sandy loam from 6 to 12 inches deep. The sand varies from fine to coarse and sharp. In that part of the type lying north of Louisa there is a small percentage of angular fragments—mineral aggregates of resistant constituents of the parent rock—that impart to the soil the feel of a loose sand with considerable interstitial loam. The subsoil is a stiff red clay, fairly free from rock fragments, except some small quartz particles. Below 26 inches it often has a greasy feel, due to particles of mica.

There are occasionally poorly-drained areas of "crawfish land" near the heads of small streams that have a yellow or bluish-white impervious subsoil. In such places the saturation of the soil has retarded or prevented aeration and subsequent oxidation, and the conditions are not at all favorable for plant growth.

The Cecil sandy loam occupies 46.4 per cent of the area. It occurs in two belts crossing the county, one occupying practically the eastern third of the county, and the other a triangular area with a basal extension of about 8 miles along North Anna River, narrowing southward to a width of 1½ miles at Louisa, where it extends southwesterly along Roundabout Creek.

The topography is about the same as that of the Cecil loam—a series of ridges and counter ridges—interstream intervals that narrow and slope toward confluences of water courses. The area north of Louisa is the more rolling and eroded. A gradual surface descent toward the eastern boundary has so moderated the slopes that erosion is a less serious problem with the large area of the type here than with the remaining soils. Surface drainage and that of the soil to a depth of 10 inches is excellent.

The soil is derived from granite and gneiss. The area farther west is the weathered product of a coarse-grained, porphyritic granite, carrying a high content of quartz and feldspathic material, mainly orthoclase, and very little muscovite mica. This disintegrates readily, but not deeply, and frequently holds its original structure to within a few inches of the surface. Erratic rounded bowlders of granite, numerous quartz fragments, and small mineral aggregates occur on the surface and mingled with the soil. South of the drainage divide the granite has a finer texture and weathers more thoroughly. The soil of the extensive area in the eastern part of the survey is derived from a uniform banded gneiss, differing essentially from the granite only in a higher percentage of mica. This rock has been tilted until the bands stand almost perpendicular. Crossing this area occur narrow interrupted belts of a rotten stone, a light, porous rock apparently a residuum of the finer insoluble materials of the original rock, cemented with iron oxide and retaining the original structure. The porosity of this rock tends to deplete the overlying 8 to 24 inches of soil of its moisture by too complete drainage.

The Cecil sandy loam, locally termed "granite land" or "gray land," taken as a whole, is the most productive type of the area. It is the easiest soil to till under a wide range of moisture conditions, and is susceptible of improvement. A deficiency in organic matter makes it apt to assume a bleached, hardened appearance in times of drought. Its original forest growth was pine, oak, and hickory. Much old field pine now stands on former cultivated fields. It is the best tobacco soil in the county, the yields ranging from 400 to 1,000 pounds per acre of a good-textured leaf. Wheat on the heavier phases of the type yields from 7 to 25 bushels, corn 15 to 40 bushels, and hay 1 ton per acre.

Cowpeas are entering into and altering a long-practiced rotation of following corn with wheat, then clover and grass from one to three years, and then tobacco. Farmers have recognized the value of this crop in improving this soil and are taking hold of it rapidly. The value of lime, used as a complement to green cowpeas plowed in, as a means of improving the soil texture and as a remedy to correct clover-sick soils is generally admitted, but this approved method is practiced as yet to a very little extent. Commercial fertilizers are used too indiscriminately and with too little forethought as to their profitableness.

Deeper plowing and subsoiling are recommended in order to reach the best results with this type.

The following table gives the average results of mechanical analyses of the fine earth of the Cecil sandy loam:

Mechanical analyses of Cecil sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
13516, 13518	Soil	3.2	15.4	10.7	26.1	13.1	17.9	13.6
13517, 13519	Subsoil	2.8	10.7	6.5	13.7	6.1	13.3	46.9

In order to obtain information regarding the manurial requirements of this soil a large sample was collected near Frederick Hall. The sample is fairly typical, but contains slightly more organic matter and has been better fertilized than the most of the land in the county. The field from which the sample was taken was cultivated prior to the war, but afterwards abandoned and allowed to lie fallow for many years. For the five years prior to 1903 it had been in grass, but was then plowed and planted to corn. It was again planted to corn in 1904, and in the fall of the same year plowed and sowed to wheat. During 1904 it received about 200 pounds of complete commercial fertilizer, a light dressing of barnyard manure, and 250 pounds of lime per acre. During the fall of the same year 250 pounds more of lime per acre was applied.

The results obtained on this soil by the wire-basket method indicate that to secure good crop yields green manures, such as cowpeas, should be plowed under and that lime should be applied. Good increases in plant growth were also secured by the use of lime and of nitrate of soda, sulphate of potash, and acid phosphate in combination. Even the use of a complete fertilizer or of stable manure without lime produced satisfactory increases in yield. The use of single constituents, like nitrate of soda, sulphate of potash, etc., did not greatly change the capacity of the soil.

CECIL SAND.

The Cecil sand consists of 12 to 18 inches of a light to medium sandy loam underlain by a yellow sandy clay or a sticky heavy sandy loam to a depth of 3 or more feet. In some of the small poorly-drained areas, approaching a "crawfishy" state, the subsoil may be of a whitish or bluish color and of a clammy, puttylike consistency. As a rule these "crawfishy" spots overlie the partially decomposed parent rock at a depth of only a few feet, while in the better drained areas the depth to rock is rarely ever less than 8 to 10 feet. The surface 6 or 8 inches of the soil is rather compact, of a light-gray color, and deficient in organic matter. Both soil and subsoil are practically free from rock fragments.

The Cecil sand is associated with the Cecil sandy loam, except in the case of the largest area of the type found around Lasley. Considerable areas occur immediately south of Centerville and Louisa, around Bumpass, and at the headwaters of Roundabout Creek. There are a number of smaller areas in the eastern third of the county.

This type occupies level areas in the higher ridges and small stream slopes which are rarely ever steep enough to cause excessive erosion. Nearly all of the smaller areas are found around the head of small streams, and in places they are poorly drained on account of seepage from higher lying areas. The wetter of these seepage areas constitute the "crawfishy" lands referred to above, and as they occur only in small spots they are not shown on the accompanying soil map. In the larger areas the drainage is good, but it is a noticeable characteristic of the type that the average depth to standing water is much less than in the Cecil sandy loam and other types at the same elevation. This may be due to the position of the folds in the underlying rock, being such as not to allow the water to pass to lower depths, or it may be due to a less thoroughly decomposed state of the underlying rock.

The Cecil sand is a residual soil, derived from granites and gneisses. The area around Lasley is derived from a coarse-grained siliceous granite, carrying very little else than quartz and white feldspar. This rock at first breaks down into a mass of quartz and feldspar aggregates, which retain the color of the original rock. These in turn break down into clay and sand with a comparatively low silt content—a characteristic of all Cecil soils derived from granites. The areas to the north and south of Louisa are of the same origin as the adjoining

Cecil sandy loam, and farther east it is of gneissic origin. Being of the same origin as the Cecil sandy loam, its difference from that type seems to be the result of poorer drainage conditions, which have retarded aeration and oxidation and the consequent decomposition of the rock constituents.

The original timber growth consisted principally of oak, pine, and hickory. Most of the merchantable timber has been cut.

The Cecil sand is a less productive soil than the Cecil sandy loam and is less easily improved. The effects of the applications of manures are not lasting, being scarcely observable after the second year.

More than one-half of the type is under cultivation and is used for the production of all general crops of the area, including corn, wheat, grass, clover, and tobacco. Being a sandy and leachy soil, it is not very well adapted to wheat, grass, and clover. The stands are often poor and the yields are light and uncertain. By following a proper rotation fair crops of corn are produced. A fine-textured tobacco is grown, and the yields are fairly good. Hay yields about one-half ton, wheat from 7 to 10 bushels, corn anywhere from 5 to 25 bushels, and tobacco from 500 to 800 pounds per acre. Instead of growing poor crops of wheat, hay, and corn on this soil, it is suggested that more attention be given to tobacco, peaches, garden vegetables, and potatoes. It is an excellent peach soil.

While lime and cowpeas do not improve this soil as noticeably as they do some other soils of the county, good results have been obtained particularly by the plowing under of matured pea vines. Crimson clover does fairly well and should be grown to a larger extent.

The following table gives the average results of mechanical analyses of the fine earth of the Cecil sand:

Mechanical analyses of Cecil sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
13512, 13514	Soil	1.3	9.4	12.1	34.9	13.9	18.3	9.9
13513, 13515	Subsoil	1.9	9.9	10.0	23.0	9.9	18.7	26.4

CECIL CLAY.

The Cecil clay, to an average depth of 6 inches, consists of a heavy red clay loam or clay of a loamy character. There is no very distinct line of demarcation between soil and subsoil, which is a heavy red clay, occasionally loamy below 24 inches on account of the presence of partially decomposed rock.

This type is not an extensive one and is confined mainly to stream slopes. Many areas too small and irregular to appear upon the map occur throughout the county, representing severely eroded phases of other types and known locally as "gall spots." The most extensive areas are those associated with the Iredell clay loam in the southwestern part of the county, and the principal area lies along Roundabout Creek.

The sloping topography is conducive of excellent surface drainage. The subsoil is too close to admit of good underdrainage, but could be improved by tile drains or most practically by subsoiling and growing deep-rooted crops to open up its structure.

The Cecil clay is a residual soil derived from granite, gneiss, and schist. Two phases were recognized, differing in the main in their origin. That in the vicinity of Poindexter and several small upland areas represent the original weathered products of the parent rock. This phase has a deeper red color and a higher crop value. The other phase represents the subsoil from which the original soil covering has been removed by wash.

The original vegetation consisted of several species of oak, pine, and hickory. The greater part of the type is under cultivation. It is considered the most difficult soil of the area to cultivate, becoming very hard and compact if allowed to remain uncultivated for any considerable period. If plowed too wet it puddles and later breaks into refractory, resistant clods.

With proper regard for its restriction of cultivation to a narrow range of moisture conditions and with thorough, deep plowing, this soil gives better yields of wheat and corn than any other type. Wheat yields from 12 to 28 bushels, corn 20 to 40 bushels, and tobacco 700 to 1,000 pounds per acre. The tobacco produced is a heavy leaf and is used for a plug filler. Orchard grass is well adapted to this type and should be grown to protect those steeper areas most inclined to washing. Subsoiling the slopes in the early fall when heavy rains are less prevalent and seeding them to winter crops is also advised.

Organic manures and lime are of the greatest use in improving the texture of this refractory type, while cowpeas and the other deep-rooted plants open up and improve the subsoil.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Cecil clay:

Mechanical analyses of Cecil clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
13508, 13510	Soil	2.6	7.9	5.8	15.9	12.2	23.1	32.4
13509, 13511	Subsoil	1.5	5.5	3.6	11.4	9.4	20.3	47.9

CECIL FINE SANDY LOAM.

The Cecil fine sandy loam consists of a grayish fine sandy loam, from 6 to 14 inches deep, the average depth being about 9 inches. Generally the soil seems to become heavier with depth, coincident with an increased content of very fine sand and silt. The subsoil is a heavy red clay, generally compact and uniform to a depth of 36 inches. Occasional poorly-drained areas have a yellow subsoil.

Through cultivation and washing the surface material on hillsides is removed so rapidly that the soil soon assumes a loamy character, and in a few years may lose almost entirely its original characteristics. It was quite difficult on some of these slopes to draw a distinct boundary between this type and the Cecil loam.

Deep plowing without the formation of clods can be done over a wider range of moisture conditions than general appearances would indicate. The soil is very deficient in humus, but with careful tillage, applications of barnyard manure, and plowing under clover and cowpeas it is the most easily and quickly improved type of soil in the county.

Most of the Cecil fine sandy loam occurs in irregular areas in the southwestern part of the county and is confined principally to slopes. Numerous streams have cut through it, leaving the backbones of interstream ridges narrow. The rolling surface affords good natural drainage. While the greater part of the type on immediate stream slopes is under cultivation, very little erosion has taken place.

The Cecil fine sandy loam is a residual soil derived from schist which weathers similarly to that giving rise to the Cecil loam, though more uniformly and deeper. This schist, however, has a higher content of siliceous material and feldspar with a probable corresponding lesser content of magnesia.

The range of usefulness of this soil covers the production of all crops grown in the area. The yields obtained, as it is cultivated ordinarily, are poor, but with proper treatment of the soil the crop yields equal those of the Cecil sandy loam. Tobacco of excellent texture yields 500 to 1,000 pounds, wheat 15 to 25 bushels, corn as much as 45 bushels, and hay 1 ton or more per acre.

A rather compact subsoil suggests the need of subsoiling. Deep fall plowing is practiced by those most successful in cultivating this soil. Good stands of clover are secured with applications of barnyard manure and seeding alone. The good remedial effects of cowpeas and lime are recognized and their use is being extended.

The following table shows the average results of mechanical analyses of typical samples of the soil and subsoil of the Cecil fine sandy loam:

Mechanical analyses of Cecil fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
13522, 13526	Soil	0.8	2.0	1.6	11.3	38.3	33.1	12.6
13523, 13527	Subsoil	.4	1.2	.8	5.7	18.7	27.5	45.2

MEADOW.

The Meadow is composed of alluvial and colluvial areas along streams, subject to frequent overflows and to seepage from higher lands. The soil is naturally wet to marshy and consists of 3 feet or more of dark sandy loam, silty loam, and sand, frequently interstratified. As a natural consequence of variation in the rate of flow this soil is inclined to be silty along rivers, while along smaller streams it tends to become more and more sandy toward their sources.

Some small areas of soils formed more or less *in situ,* kept wet and marshy by seepage, have been included in the Meadow. At least small strips are found along all branches and creeks, but these are frequently too narrow to be represented on the soil map. The most extensive areas occur in the concaves of bends of the North Anna and South Anna rivers. Frequent bluffs, sometimes 50 feet or more high, occurring on the convex side of bends, have forced the overflow to the opposite side, thereby widening the flood plain there.

All streams overflow during the year and deposit each time a layer of material derived from the various soils in their drainage basins. Where the current of smaller streams has been retarded by crooks or an obstructed channel, Meadow areas are being built up and widened. Considerable areas of formerly well-drained and productive bottom land have been rendered marshy and unfit for other purposes than pasturage through failure to keep the channels cleared of obstructions.

While much of the Meadow is under cultivation, the greater part is forested with water-loving trees and shrubs. By ditching against seepage water and straightening channels practically all this land could be brought under cultivation and made the best corn land in the area. It is well adapted to certain varieties of hay, sorghum, and oats. Good tobacco crops are made on the higher lying and more sandy phases. It is the only land of the area on which crops can be grown continuously with success. The likelihood of overflow, however, makes crops more or less uncertain on this type.

AGRICULTURAL METHODS.

The present methods of agriculture in Louisa County have been evolved from practices of many years, and while perhaps adhered to too closely they are to a certain degree suited to and enforced by existing conditions.

As a natural sequence to the little variety of soils and topography and the homogeneity of population the methods are strikingly similar over the entire area. Cultivation is never interfered with seriously by the occurrence of stones or intractableness of soils and can be carried on with facility over a wide range of moisture conditions, except upon the heavy types—the Iredell clay loam and Cecil clay—and the "crawfishy" phases of the other types.

The prevailing rotation, the result of more than a hundred years of experience, has been invaluable in preventing deterioration of the land, but lacks in not rapidly improving the soil—a defect which is probably in part due to the fact that in the crop rotation the grass and clover are too frequently cut for hay and the stock allowed to graze down the sod. Primarily the soil needs organic matter and not enough is incorporated with the rotation practiced, the general plan of which is to follow corn with wheat, sown with clover and grass, superseded by tobacco after the removal of two or three crops of hay. Organic matter can be supplied by the introduction of frequent crops of cowpeas, which not only afford a ready means of increasing the humus content of the soil, but also improve the structure of the soil and subsoil of every type of the area. Barnyard manure is excellent in its immediate and lasting effects. While the available supply of it is inadequate an increased production would entail an extension of the stock industry. Increased stock raising, coupled with improvement of the grass lands, could not be otherwise than profitable, as has been proved in a few instances where farmers have bought up cattle and fattened them for market.

The land receives an initial preparation with one, two, and occasionally three horse plows, to a depth of 4 to 9 inches, or an average of about 5 inches. It is harrowed once or twice, listed for ridge-grown crops, or seeded to grain. Wherever the subsoil is within 9 to 11 inches of the surface, except with the Cecil sand, plowing should be deep enough to turn a portion of the underlying clay to the surface so as to get the benefit of the pulverizing action of frost. Fall plowing is practiced extensively, and if done deep enough with shallower early spring plowing to reduce clods and retain moisture the land can be put into a very favorable textural condition. Subsoiling the heavier types is manifestly advisable on account of their compact nature. The extreme plasticity and unyielding nature of the Iredell clay loam practically forbids subsoiling. An old and popular practice of "laying by" corn and tobacco by turning, with deep furrows, the soil from the center of the rows, leaves the plants on ridges 6 to 8 inches high, with deep, interridge, gutterlike furrows. This ridge not only increases the surface exposed to evaporation and the baking effects of the sun, but breaks numerous lateral roots and brings the root system nearer to the heat of the sun. Scarcity of labor is said to retard the extension of the better plan of more nearly level cultivation, particularly with corn, it being necessary at times to check the growth of weeds and grass by turning them under, which can be accomplished easier with ridge cultivation.

The difficulty experienced in recent years in getting a good stand of clover, apart from the good effects of liming, could be remedied by putting the soil into a more pulverulent state and seeding alone rather than with wheat, as is the common practice. The available water supply for the young plants in the spring thus would be increased in the absence of wheat which makes its greatest growth at this season and deprives the young plants of their due proportion of water. Farmers adhere to the fallacy that they are forced by the scarcity and uncertainty of labor to secure in this way the greatest possible acreage returns, overlooking the probable greater returns to be had through the permanent benefit that good crops of clover bring to the soil.

Tobacco generally is planted from the 15th of May to the 20th of June on land plowed in the fall. However, considerable setting is done late in July, but good mature crops are more certain with the earlier setting. Probably more than half the crop is cut and immediately hung to air cure in barns. The remainder is allowed to wilt in the sun from a few days to a week or more, in some instances, according to the state of weather. Ordinarily tobacco grown on similar soils has about the same quality at the time of maturity, the great range in prices obtained for the cured leaf having to do with the farmer's individual ability to handle properly the matured crop.

Very little ditching or terracing is done. Land can be kept from washing by deep cultivation and growing grass and winter cover crops. Poorly-drained "crawfishy" areas can be cultivated profitably only by extensive ditching and by plowing the land into high beds with deep water furrows.

Improved farm machinery is coming into use among the successful farmers about as extensively as the soil conditions warrant.

AGRICULTURAL CONDITIONS.

Though the soils of the county as a whole are rather less productive than the average for Piedmont soils, the farmers generally get a good price for their principal product, tobacco, make a comfortable living, and have generally substantial houses. The stock industry is very limited and the average area under cultivation small; consequently only small barns are needed for the few cattle and necessary working stock. In the "Green Springs Neighborhood," in the vicinity of Poindexter, there are a number of large and rather imposing dwellings, built in antebellum days, but here the progress of agriculture since the war has been less marked than elsewhere in the county. Rail fences have been replaced largely by wire. The farm machinery as a rule is modern, but too often is left out of doors when not in use. Frequently reapers and mowers are left for months exposed to all sorts of weather.

During the past ten years the unfortunate system whereby merchants furnish supplies in advance at necessarily exorbitant prices has declined greatly, and this in itself is indicative of a general betterment of the farmer's condition. Probably more than three-fourths of the farms are free from incumbrance.

The condition of agriculture on the Cecil loam where farms are generally small and confined to slopes indicates less prosperity on this type of soil. The unfavorable crop yields, with the general indifferent treatment of the type, combined with its reputed unproductiveness, have discouraged development. From the fact that mining has been and is still the main occupation of the inhabitants, a considerable area north of Mineral, along Contrary Creek, might be classed as nonagricultural. The greatest general prosperity is shown on the Cecil sandy loam.

The 71.5 per cent of farms operated by owners constitute the most profitably managed soils. Renters have shown such little regard for soil improvement that land cultivated by them is ordinarily considered less desirable and has a lower market value.

There are two general systems of farm tenancy. In one the renter gives the landlord one-half the crop for the use of land, tools, stock, and feed for stock. In the other he gives one-fourth of the crops for the use of land alone. Firewood and houses are furnished without charge.

The price of land, except that in the vicinity of the pyrites mines on Contrary Creek, has never been inflated by booms. The Cecil sandy loam can be bought for from $2.50 to $15 an acre, and the other types generally for from $2 to $10 an acre. Acreage valuation has been fixed at these apparent low figures by a custom of selling as a whole farms that contain generally more or less unimproved or deteriorated land.

Farms vary in size from about 25 to 1,000 acres, the average being 105.9 acres. Formerly the farms were much larger. The antebellum plantations not infrequently contained 5,000 or more acres. The larger farms at present are found in the western part of the county. Real estate agents are having much to do with reducing the size of farms by dividing up tracts of land and selling small areas to immigrants.

The supply of labor is far below the demand. Here, as in some other agricultural regions, the tendency among young men seems to be to take up other occupations or professions rather than agriculture. Most of the able-bodied colored labor has drifted to the cities or is employed on public works, railroad building, and in the mines.

Wages are too far below market value to attract even a small migratory class. An adult farm hand commands $8 to $16, with board and lodging, a month. The introduction of a wage scale approximating market prices has failed so far because of the lack of a few progressive or experimentative farmers willing to take the initiative. At present the alternative seems to rest in the sale of small farms to immigrants who do their own work.

A significant result of this labor problem has been the enforced intensive treatment of a relatively restricted acreage with subsequent increased crop yields. Farmers relying upon the aid of their immediate families find it difficult to manage, on an average, more than 5 acres of tobacco, 10 to 30 acres of corn, and perhaps a similar acreage of grains, grass, and other crops.

Virginia sun-cured tobacco, a popular chewing type, produced in Louisa and several neighboring counties, is a light-brown, moderately oily and gummy leaf of medium size. "Sun-cured," applied to the crop as a whole, is rather a misnomer, in that the former practice of curing in the sun has been supplanted largely by curing in well-ventilated barns, by which process the cured leaf is only a little darker. The demand is for a darker leaf than formerly was produced.

Ordinarily not enough corn and hay are grown to supply the needs of farmers, many having to purchase to supplement the shortage. The wheat crop falls far short of what is needed for home use. Considering the fact that some of the farmers ship it at a profit, together with its importance in the most successful crop-rotation scheme, it would seem to merit more recognition than it now receives, and certainly the production should be increased to the extent of supplying the local demands.

While excellent vegetables are grown easily, some farmers buy considerable quantities of cabbage, potatoes, etc. Violets are grown and shipped at a profit. Nearly enough pork is produced to supply local consumption. In the fall many hogs are fattened on acorns.

The rotation practiced tends to lessen the attention paid to the adaptability of soils to crops. Upon every soil type, except the Iredell clay loam, which is too heavy for tobacco, are grown about the same crops with but little specialization on account of soil variation. The sandier soils make a finer-textured tobacco, and it is the rule to select them for "tobacco lots." Careful management narrows the range of prices obtained for the leaf, and a larger yield on the heavier soils and phases balances differences in quality, thus preventing the restriction of the crop to sandy soils.

The superior quality of the leaf grown along Roundabout Creek has given the soils of that neighborhood a reputation for being particularly adapted to tobacco. It is ventured that a great deal more here depends upon the management of soils and manipulation of the matured leaf than popular opinion concedes.

The Cecil clay, Cecil sandy loam, and the Meadow are best suited to corn with present methods. By force of habit a certain acreage is put in corn from year to year, with little regard sometimes as to the suitableness of the soil. It is generally recognized that the heavier soils are best for wheat and grass, but the practice of growing these crops only as necessary crops to precede tobacco is not an observance of this adaptation.

The Iredell clay loam, at one time considered the best wheat soil in the State of Virginia, through scarcity of labor and capital, has had its acreage yield reduced from 40 to about 15 bushels.

Apples, particularly the winesap, flourish on most of the soils, but do best in slight southern-exposed depressions. It is claimed that peaches are short lived and unproductive. Poorly-drained areas are best adapted to sorghum, millet, and herd's-grass.

The Chesapeake and Ohio Railroad, crossing the county near its center, affords good transportation facilities for the greater part of the county. In the southeastern part there are shipping points on the James River Division of the Chesapeake and Ohio Railroad. Most of the tobacco from this section is hauled unprized to Richmond.

Nearly all roads have cut into the clay subsoil and have a compact, smooth surface in summer, while in winter they are quickly cut and rutted, becoming almost impassable in many places. Vehicles of a broader tread have been advocated, but are not likely to come into general use without legislative action. They undoubtedly would prevent to some extent the rutting of the highways.

There are no towns of importance in the area. Louisa, the county seat and largest town, has a population of about 500. However, there are convenient shipping points along the railroad. Richmond, the general market for the area, is about 50 miles by railway from Louisa. Flowers gathered in the afternoon are placed in northern markets the following day.

SOIL SURVEY OF HANOVER COUNTY, VIRGINIA.

By HUGH H. BENNETT and W. E. McLENDON.

LOCATION AND BOUNDARIES OF THE AREA.

Hanover County, situated just east of the center of Virginia, is included within parallels 38° and 37° 30′ north latitude and meridians 77° 50′ and 77° west longitude. Its extreme length from east to west is about 37 miles, 12 miles of which lie within the Piedmont Plateau. In width it measures approximately 11½ miles along the eastern boundary, 7 miles across the center, and 20 miles along the western boundary. The area of the county is 475 square miles or 304,000 acres. The northern boundary is formed by the North Anna and Pamunkey rivers, the latter being a continuation of the former, which flow in a general southeasterly direction. Owing to the numerous bends in these streams, the northern boundary is irregular. The Chickahominy River, rising about 10 miles east of the southwestern corner of the county, flows in a southeasterly direction along the southern boundary roughly parallel with the streams forming the northern boundary. Included between these rivers the county forms

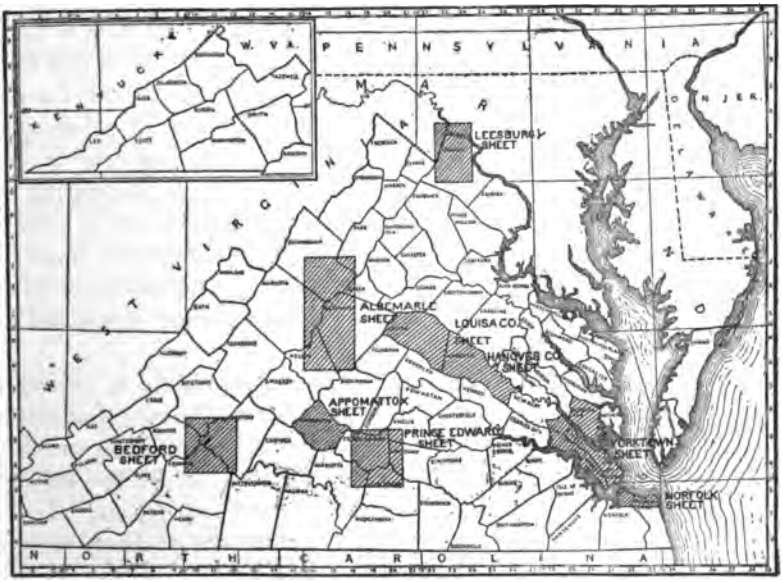

FIG. 7.—Sketch map showing location of the Hanover County area, Virginia.

a long, narrow strip running from northwest to southeast. It is bounded on the north by Spottsylvania, Caroline, and King William counties, on the east by King William and New Kent counties, on the south by Henrico and Goochland counties, and on the west by Louisa County. Ashland, the largest town, is situated very near the center of the county and is about 99 miles south of Washington, D. C., and 16 miles north of Richmond, Va. Hanover is the county seat.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Hanover County was formed from a part of New Kent County by an act of the colonial legislature passed in 1720. In 1742 a large part of the western portion of the county was cut off and organized as Louisa County. The early settlers came either from the early English colonies or direct from England. The population for the most part is of almost pure English descent.

The early agricultural practices were very crude. Little manure was used and no definite crop rotation practiced until about the middle of the nineteenth century. Prior to the Revolutionary war the land was cultivated continuously to tobacco, and when the yields ceased to be profitable new land was cleared and devoted to this crop. The growing of tobacco generally proved profitable to the farmers and its cultivation so engrossed their attention that all other crops were subordinated to it. To lessen the evils of this one-crop system the colonial legislature enacted laws from time to time restricting the tobacco acreage of the farms and requiring the cultivation of a stipulated acreage of other crops. Standards of quality were fixed for tobacco intended for exportation, and public warehouses were designated through which the crop was sold after being inspected by public officials.

At the close of the Revolutionary war there came a period of agricultural depression, brought on largely by decreased productiveness of the cleared fields and low prices for tobacco. The prices of cereals advanced and their production increased, while the tobacco acreage diminished, particularly in the Coastal Plain region. Later, however, the demand for cereals decreased and the profitableness of tobacco increased. Because of the declining yields of the soils of the Coastal Plain region, its production was confined almost entirely to the Piedmont Plateau and brought an exceptional degree of prosperity to the farmers of that region. The early plan adopted for handling those fields that had become too poor for profitable crops of tobacco was to cultivate them in corn for about three years in succession, then every second year so long as yields of about 5 bushels per acre were obtained, and after this to abandon the land and clear new fields. The soil was "rested" between corn crops, either under a crop of small grain or allowed to lie fallow.

About 1850 the farmers began treating the soils of the Pamunkey bottoms with greensand marl obtained from deposits along the river. Applications of this material, made sometimes at the rate of 250 or more bushels per acre, proved quite beneficial and were said to be very lasting in their good effects. The greensand marl was applied in some instances in conjunction with organic manures, it being recognized that the best results were obtained in this way. About this time cowpeas and clover were introduced in some localities as regular crops, along with wheat and corn, in a six-year rotation, and were plowed under, grazed, or cut for hay. The practice of "marling" has not been attempted on an extensive scale since the civil war.

Prior to the civil war each plantation was entirely self-sustaining and had its own distinct round of occupations, which were so much alike from year to year that the details of farm management could be intrusted to overseers. Following the war changed conditions forced the abandonment of a large acreage of farm land, much of which is now covered by a heavy growth of old field pine. After an adjustment to the new conditions more intensive cultural methods became the rule, and a great deal more attention was paid to the manurial requirements of the soil.

CLIMATE.

The following tables show the normal monthly and annual temperature and precipitation, and the dates of first and last killing frosts, as given by the Weather Bureau records at Ashland.

Normal monthly and annual temperature and precipitation.

Month.	Ashland.		Month.	Ashland.	
	Temperature.	Precipitation.		Temperature.	Precipitation.
	°F.	*Inches.*		*°F.*	*Inches.*
January	36.0	2.85	August	76.0	3.92
February	36.5	3.48	September	69.5	5.15
March	48.2	3.41	October	57.8	3.84
April	56.0	3.67	November	48.0	2.49
May	66.1	4.78	December	38.9	2.97
June	73.0	3.53	Year	57.0	44.81
July	78.0	4.72			

Dates of first and last killing frosts.

Year.	Ashland.		Year.	Ashland.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1897	Apr. 21	Oct. 31	1902	Apr. 14	Oct. 15
1898	Apr. 7	Oct. 24	1903	Apr. 6	Oct. 19
1899	May 17	Oct. 6	1904	Apr. 22	Oct. 16
1900	Apr. 10	Nov. 10	Average	Apr. 16	Oct. 22
1901	Mar. 29	Oct. 26			

These records are believed to represent quite accurately the average climatic conditions for the county. On account of a difference in altitude of something like 200 feet the climate of the region near the western boundary is slightly cooler than that of the district near the eastern boundary, but there is no apparent difference in the precipitation. The climate of the North Anna-Pamunkey Valley is more unfavorable for early crops than that of the adjacent uplands, because of the tendency of the heavier cold atmosphere to settle in the valley.

The range of temperature between normals for January, the coldest month, and July, the hottest month, is about 42° F., while the absolute maximum range is probably not much greater than 110° F. On the whole, the climate is equable and healthful and is quite favorable to agriculture. Injurious hail storms and winds are infrequent. With good drainage and proper seeding, little damage is done to grain by heaving of the soils, due to alternate freezing and thawing. Red clover is frequently more or less winter killed where the seeding has been done late. Peaches are subject to serious damage by the alternate warm and cold spells of early spring. There are some wild fruits, such as the blackberry and dewberry, that rarely bloom until after the danger of frost is past. Although the rainfall is heaviest during the growing season, the longer continued rains of spring, together with less evaporation and less absorption by the more thoroughly saturated soils, cause more freshets in the spring than occur at any other season. The characteristic dry falls are favorable for harvesting crops and curing tobacco, but are often unfavorable for fall-seeded grain. The heavy dews appearing during the latter part of August are quite beneficial in thickening up filler plug leaf tobacco. Cold nights without dews about the time of maturing are said to prevent to some extent a perfect development of the leaf.

PHYSIOGRAPHY AND GEOLOGY.

Hanover County comprises two main physiographic divisions—the Piedmont Plateau, which lies west of a curved line crossing the area in a north and south direction about 3 miles west of Ashland, and the Coastal Plain, which lies east of this line. There are two distinct subordinate physiographic divisions—the North Anna-Pamunkey Valley and the zone marking the coalescence of the Piedmont with the Coastal Plain regions.

The general surface configuration of the Piedmont Plateau, represented in Hanover County by the eastern border of that great physiographic division, is that of a plain much dissected by a highly diversified stream system. In Hanover County the slope from east to west is barely perceptible, although there is a drop of from 50 to 100 feet in a distance of a little over 12 miles. The Piedmont division of the county is well drained by the North Anna, Little, New Found, and

South Anna rivers. For a distance of 9 or 10 miles from the western boundary these streams flow almost parallel to one another, but draw closer together as they approach the point of confluence with the Pamunkey River. By the cutting of deep valleys these streams have formed a series of roughly parallel ridges, growing narrower toward the east, with crests approximately 100 feet above the stream beds. These major ridges, constituting true drainage divides, are flanked by irregularly developed secondary ridges formed by the smaller streams that rise near the crests of the divides and flow nearly at right angles into the main water courses. With the settlement of the region and the subsequent deforestation of the land a larger proportion of the rainfall was carried off with the surface drainage. For this reason many former perennial streams have become dry except during seasons of rainfall and have formed numerous shallow V-shaped ravines and gullies. There are no table-land divides, the valley sides rising with diminishing slope toward the ridges. In the immediate vicinity of the streams the slopes are more abrupt and marked by greater surface inequalities. The greater part of the area is gently rolling, owing to the comparatively shallow valleys of the streams in their upper courses. Generally the altitude at any one point is proportionate to the distance from large streams.

The Coastal Plain division of Hanover County has an altitude of about 250 feet on the west and 175 feet on the east, and represents the more elevated portion of that physiographic province. Excepting the deeply cut drainage system, which resembles closely that of the eastern Piedmont, the general upland topography of this section is quite similar to that of the typical Coastal Plain farther east. This division, included between the lowlands of the Pamunkey River on the north and the Chickahominy River on the south, constitutes a nearly level plateau cut by deep valleys of winding streams which rise in the irregularly developed drainage divide following, and very near, the Chickahominy River. These streams flow in a northeasterly direction and empty into the Pamunkey River. A narrow strip, constituting the southern slope of the drainage divide, is drained by numerous small, short streams that empty into the Chickahominy River. The valleys are deep and generally narrow, their steep walls reaching the level of the uplands within a comparatively short distance of the streams. In the neighborhood of the larger waterways the gulleylike escarpments of the short laterals give the country a rolling topography. The interstream country, corresponding to the main ridges of the Piedmont division of the county, consists of flat to gently rolling expanses frequently poorly drained near their centers. The section north of Ashland is cut by the rivers that converge in that vicinity to form the Pamunkey, and is quite rolling and well drained.

The Piedmont grades into the Coastal Plain so gradually that the boundary was established with considerable difficulty. South of the South Anna River this boundary passes through a kind of gradational zone or province having a distinctly level to gently undulating surface cut only by shallow streams. This grades insensibly into the more definite Coastal Plain province a few miles east of Ashland. The center of this zone is somewhere near the town of Ashland, where there is a faintly developed table-land, slightly depressed, and very poorly drained.

Commencing about where the Richmond, Fredericksburg, and Potomac Railroad crosses the North Anna River, running down that stream to its junction with the Pamunkey River, and thence down the Pamunkey, is a well-developed terrace formation. This comprises first and second terraces, interrupted by numerous secondary terraces, and lies approximately between 30 and 55 feet above the level of the river. There is little or no slope riverward, but a gradual steplike descent of the numerous secondary terraces. Excepting some of the narrow, low-lying areas adjacent to the river, this terrace formation is never overflowed. The outer limit of the river plain is marked by a distinct bluff line which rises abruptly to the level of the upland. The Pamunkey River is deep and flows rather sluggishly. The water table frequently lies within 7 or 8 feet of the surface of those areas along the river that are underlain by a coarse gravel substratum.

The soils of the Piedmont section of the county have been derived mainly from the granite and gneiss formations, belts of which cross this part of the county in a northeast and southwest direction. The distinctly banded and greatly tilted character of the gneiss near the western boundary becomes less conspicuous toward the east. The granite and gneiss are so similar in composition and so intimately associated near the Coastal Plain boundary, where there are few rock exposures, that it is often hard to determine whether the parent rock of a given soil formation is granite or gneiss. A few rock variations have given rise to small, unimportant nonconformations in the soils. Weathering has taken place very uniformly to a depth of 30 feet or more, and with the exception of quartz fragments—the remnants of quartz veins that intersect this entire region—rock fragments are very scarce. The deeply weathered rocks have exerted little influence upon the topography. Streams cross the region without reference to the rock formations and have cut deep steep-sided channels without exposing the underlying rocks. Northwest and north of Ashland, however, occurs an area of very resistant Newark conglomerate, which, while it has had no appreciable influence upon the overlying soils, has determined the character of the topography in the neighborhood of the streams. Here the streams are frequently flanked by precipitous rock walls 50 feet or more in height, the valleys are narrow, and bottom land is practically absent.

The Coastal Plain division of the county, exclusive of the terraces of the North Anna-Pamunkey Valley, belongs to the Lafayette formation. It consists principally of loose sandy loams underlain by yellow sandy clays, and represents materials washed from the Piedmont and laid down near shore during the period of submergence of the area. These materials, subjected to the action of tides and waves during the shallow-water stages of the subsequent uplift of the ocean floor, were greatly modified, assorted, and distributed over the Coastal Plain area. Since the final uplift they have not been changed materially, except along slopes, where the finer particles have been carried away by rains and streams, leaving the coarse sands and gravels. The soils differ from those of the Piedmont in their loose structure, lack of loaminess, the predominance of sand—generally more or less rounded—and the frequent occurrence of waterworn gravel throughout the soil profile.

The western boundary of the Coastal Plain province is much farther east than formerly, as is evidenced by the beach-worn pebbles scattered over the eastern margin of the Piedmont, showing the existence there of a former mantle of these unconsolidated materials. There are included in this province several isolated outliers of the Piedmont, a mile or more removed from the boundary.

In its lower depths the Lafayette consists of a coarse sandy or gravelly loam, often showing stratification and cross-bedding. The Lafayette rests unconformably upon the Chesapeake formation, indistinct outcrops of which are probably seen in the gray or olive clays along the slope bordering the Pamunkey River bottom and the small stiff clay spots west of Polegreen. The materials of the Chesapeake formation have little direct influence upon the soils. They may, however, have entered into the formation of the heavy soils of the Columbia terraces.

The river terraces represent the fluvial phase of the Columbia formation, and to a depth of 15 feet or more consist of coarse sands, sandy loams—becoming coarser below about 3 feet—and clays. These constitute materials of the original Coastal Plain, and, to a less extent, of the Piedmont, reworked and intimately mixed by water currents of recent Pleistocene time.

The Columbia terraces overlie the Pamunkey formation of the Eocene. This formation is exposed along the Pamunkey River, and consists mainly of glauconitic sands and marls of a dark-green or grayish-green color. It contains many calcareous shells and shell fragments. These greensand marls have little influence on the soils of Hanover County, but have been used extensively as fertilizers. They contain small quantities of phosphoric acid, lime, and potash.

Nearly every stream in the county is bordered along the greater part of its length by a narrow strip of Meadow or alluvium, the result of overflow depositions and the accumulation of material washed down from the adjacent slopes. The area of this soil formation is being gradually increased at the expense of other soils which are being worn away by erosion. A considerable percentage of this is marshy, but is susceptible of reclamation by artificial drainage.

SOILS.

Twelve distinct soil types were encountered in Hanover County. The classification of these was based largely upon their texture, that is, the relative proportion of the various sizes of the constituent soil particles—sand, clay, and silt—as determined by mechanical analyses. Here, as with most soils, texture determines in a large measure the relative productiveness of soils, since it practically controls moisture conditions and the circulation of air in the soil. This is more nearly true for soils under relatively similar conditions and depends considerably upon soil structure, that is, the arrangement of the soil particles with relation to each other—whether compact or granular—and upon the position of the soil, whether in low-lying, poorly-drained situations or the reverse. This last influence can be altered by cultural methods and artificial drainage. The texture of the soil can be modified by the incorporation of vegetable matter. Thus, an open sandy soil from which water drains away rapidly can be made spongy and capable of maintaining a favorable moisture supply in dry seasons by plowing under well-rotted organic matter.

Some of the types in Hanover County owe their distinguishing characteristics and even their origin to accident of position. The Leonardtown loam owes its peculiarities largely to the fact that its flat surface is not conducive to good natural drainage. The Norfolk gravelly loam and the Cecil clay owe their origin, respectively, to the washing out of the fine particles from the Norfolk sandy loam and the Norfolk fine sandy loam occupying slopes and the washing off of the soil from Cecil sandy loam areas.

The boundaries of the different types were easily determined except in the case of the Cecil sand and the Norfolk sandy loam, which grade into each other so as to make the line of separation very indistinct.

The following table shows the actual and relative extent of the different soils:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Cecil sandy loam	97,856	32.2	Swamp	6,208	2.1
Norfolk sandy loam	88,256	29.0	Wickham sandy loam	5,120	1.7
Norfolk fine sandy loam	39,232	12.9	Wickham sand	4,416	1.4
Cecil sand	29,696	9.8	Wickham clay loam	2,176	.7
Meadow	15,552	5.1	Norfolk gravelly loam	1,344	.5
Cecil clay	7,360	2.4			
Leonardtown loam	6,784	2.2	Total	304,000	....

CECIL SANDY LOAM.

The soil of the Cecil sandy loam to a depth of from 6 to 16 inches consists of a gray to light-brown medium sandy loam, generally of a more open and coarser texture in the surface 6 inches. The subsoil is a red sandy clay which becomes heavier, stiffer, and more intensely red with increase in depth. The subsoil is inclined to be friable where the drainage is good. Sharp, angular quartz fragments, varying in size from small particles to pebbles about one-half inch in diameter, usually occur throughout the soil profile, but seldom in quantities sufficient to impart a distinctly gravelly nature to the soil. The sand is sharper and more angular than that of adjacent Coastal Plain soils. Near the Coastal Plain boundary the type is decidedly more loamy, more nearly uniform in texture, depth, and topography, and is almost entirely free from rock fragments.

The Cecil sandy loam occupies nearly 75 per cent of the Piedmont section of the county. With the exception of a few small, detached areas it occurs in one general body broken throughout by erratic areas of Cecil sand and, in the southwestern corner of the county, by irregular bodies of Cecil clay. Its surface features consist of a series of irregularly developed ridges with crests approximately 100 feet above the beds of the main water courses. These major ridges are flanked by a series of secondary ridges, included between escarpments of small streams rising near the crests of the main ridges and flowing almost at right angles into the larger streams. These stream escarpments are comparatively shallow, except in a small part of their lower course, and for this reason the greater part of the surface varies from undulating in the higher positions to gently rolling near the major stream valleys, the walls of which are quite steep and rolling. Frequently the soil of the steep valley sides has been made shallower or has been entirely removed by erosion. Small areas where the subsoil has been exposed in this manner are locally called "galls." Usually the slopes are so gentle and the soil so absorbent of rainfall that surface wash has done but little harm. Natural drainage for the most part is very good, practically no ditching being done.

There are many small irregular areas which, because of poor drainage, differ somewhat from the general description of the type, particularly in the neighborhood of Beaverdam. These areas are locally known as "crawfish lands" and usually occur near the sources of small streams. They consist of a gray sandy loam about 5 inches deep, underlain by a very clammy, plastic, mottled white and blue sandy clay. Water is held in the soil almost immovably, as if it were a part of the soil itself. This characteristic may be due in part to a too even distribution of the soil particles that divide the interstitial space into a great number of minute pores, through which water is distributed and held by capillary attraction so as to overcome gravitational flow. Frequently the unmanageable nature of the clay is erroneously ascribed to the action of crawfish, great numbers of which make their homes here. The extensive ditching necessary to reclaim these "crawfish land" areas practically precludes their use for agricultural purposes.

The Cecil sandy loam is a residual soil, derived from the weathering of granite and gneiss rocks carrying little mica but considerable feldspathic material. Weathering has taken place very uniformly to an average depth of about 30 feet. The sandy material constituting the soil portion of the type probably represents accumulations of the coarser constituents—the residuum left upon removal of the finer particles by erosion—of a section of soil material many feet thick and perhaps not greatly unlike the subsoil. Few rocks, with the exception of quartz fragments—the remnants of quartz veins that intersect this region—are met with. Occasionally waterworn gravel has been left on the surface along the eastern boundary of the soil type by the removal of the finer particles of a Coastal Plain material that formerly overlapped the present margin of the Piedmont.

At one time about three-fourths of the type was cleared, nearly one-half of which has since been allowed to grow up in old field pine. The original forest growth consisted principally of oak, hickory, and pine.

The Cecil sandy loam, while not so productive as the Cecil clay, is the most important of the Piedmont soils because of its great extent. It is easily cultivated and is quite susceptible of improvement. The soil needs organic matter, which can be supplied by growing cowpeas and clover. Applications of lime also prove beneficial. The plowing under of cowpeas and crimson clover is fast becoming a general practice. Instead of plowing under the pea vines while green, the crop is allowed to stand until matured, and is then either plowed under in the fall or else allowed to remain as a cover crop through the winter. The latter practice is said to preserve loaminess and moisture quite as well as when the crop is turned under while green. Considerable commercial fertilizer is used in the form of acid phosphate or "complete fertilizers," carrying generally about 8 per cent of phosphoric acid and 1 per cent each of potash and nitrogen. The average application for tobacco is from 300 to 500 pounds per acre sown in the row, for corn 100 to 200 pounds in the row, and for wheat about 350 pounds sown in the drill with the grain. More lime should be used on this soil type. While the plowing as a rule is deep, it should be much deeper in some localities.

The Cecil sandy loam is devoted to general farming. Tobacco has been the staple crop for a long time. The yields range from 600 to 1,000 or more pounds per acre. It makes an excellent plug or chewing tobacco and commands good prices. The curing is done in well-ventilated barns. Some of the farmers "scaffold" the leaf in the sun for several days, or until it is thoroughly wilted, before it is put in the barn to be air cured. The tobacco grown in this region is placed upon the market as "Virginia sun-cured." Corn yields from 15 to 40 bushels, wheat from 7 to 25 bushels, oats about 30 bushels, and hay about 1 ton per acre. The hay generally consists of a mixture of clover, herd's-grass, and timothy or pea vines.

The following table gives the average results of mechanical analyses of samples of the fine earth of Cecil sandy loam:

Mechanical analyses of Cecil sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14145, 14147	Soil	3.6	12.7	8.1	25.9	12.2	24.9	12.4
14146, 14148	Subsoil	2.2	7.3	4.9	14.3	9.3	16.9	44.8

CECIL CLAY.

The soil of the Cecil clay to a depth of from 4 to 10 inches consists of a red clay or clay loam, usually containing appreciable quantities of medium and coarse sand near the surface. The subsoil is a brittle heavy red clay, becoming heavier and stiffer with depth. Frequently below a depth of 28 inches it has a distinctly greasy feel, due to the presence of minute particles of mica, and contains soft concretions of hydrated oxides of iron and coarse angular sand or fragments of quartz. A slight variation is found in the higher situations representing heavily timbered areas. Here the type is a dark-red mellow clay loam, 16 inches deep, underlain by a brittle chocolate-colored clay containing but few quartz fragments.

The Cecil clay occurs in irregular-shaped areas in the southwestern part of the county, occupying mainly the slopes of the South Anna River, Taylors Creek, and their tributaries. Small areas occur along the undulating ridge crests. The rolling topography is conducive to excellent surface drainage, and the general absence of severe erosion indicates a good water-holding capacity and better underdrainage than the textural character of the subsoil would suggest. If plowed when too wet, very resistant clods are formed or the soil runs back into the furrow, puddles, and becomes very hard when dry. On the other hand, if allowed to remain too long without plowing after a heavy rainfall the soil bakes and when plowed large, unmanageable clods are turned up.

The Cecil clay is a residual soil, derived from the weathering of granite and gneiss in a manner similar to that giving rise to the Cecil sandy loam. That part of the type occupying the steeper slopes seems to have had a former sandy covering which has been removed by erosion, while the higher lying, dark-red phase of the type probably never had this sandy mantle. This last phase is timbered with a heavy growth of oak, pine, and hickory.

A large percentage of the type is under cultivation. It is very productive and is well adapted to general farm crops, particularly corn, small grain, grass, and tobacco. When thoroughly prepared and cultivated under favorable moisture conditions it produces from 30 to 50 bushels of corn, from 12 to 25 bushels of wheat, 1 ton or more of hay, and from 800 to 1,200 pounds of tobacco per acre. The tobacco, while not as fine textured as that produced on the Cecil sandy loam, is quite as profitable, since the lower price is offset by the heavier yield. If thoroughly prepared before seeding, this soil is especially suited to red and crimson clover, timothy, and orchard grass.

In dealing with this soil the chief problem is to maintain a loamy condition so as to preserve a favorable moisture supply, without which the crop yields can not be expected to approximate the soil's maximum productive power. The compactness of the soil particles needs to be disturbed by deep, thorough, and seasonable plowing and a spongy, open structure brought about by the incorporation of vegetable matter, particularly pea vines and clovers. Turning under green manures is at present disapproved by the majority of farmers, who claim better results are had by turning under dried vegetable matter. As to pea vines, it is claimed that the land is much benefited by allowing the vines to remain through the winter as a cover crop. The use of lime with green manuring would greatly increase the beneficial results to be had from this practice. A regular rotation of crops is also important. The prevailing practice is to follow wheat by grass and clover, the clover being cut for two or three years and then succeeded by corn or tobacco. Cowpeas are generally sown between the corn rows with the last plowing. Considerable commercial fertilizers are used.

The following table gives the average results of mechanical analyses of samples of the Cecil clay:

Mechanical analyses of Cecil clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14151, 14153......	Soil.........	1.9	9.0	7.9	19.9	9.4	26.4	25.6
14152, 14154......	Subsoil.....	2.3	8.7	6.4	13.6	5.2	20.3	43.3

CECIL SAND.

The Cecil sand to a depth of from 6 to 10 inches consists of a light-colored medium sandy loam, underlain by a loose, incoherent, pale yellow material of about the same texture extending to an average depth of 18 inches. This rests upon a yellow sandy loam, which in depressed and poorly drained areas grades into heavy sandy loam or sandy clay, frequently mottled and clammy. In the vicinity of the Coastal Plain boundary the soil becomes more loamy and the subsoil is a heavier sandy loam, quickly passing into a sandy clay. Here there is little variation in the type. Its close resemblance to the contiguous Norfolk sandy loam, from which it seems to differ merely in origin, made it somewhat difficult to draw a distinct boundary between the two. The absence of waterworn gravel from the profile of the latter type, however, helped to establish a fairly accurate boundary between these gradational soils.

The Cecil sand occurs throughout the Piedmont section of the county in numerous widely separated areas which range in size from a few acres to approximately 1 square mile. A large percentage of the type is included in the irregular bodies occupying the drainage divide to the south of the North Anna River and the large body in the southeast corner of the Piedmont. The smaller areas generally occupy undulating ridge crests near the sources of small streams, while the larger areas cross the ridges and follow the slopes down about half the distance between the stream and the crest of the ridge. The extensive area in the southeastern corner of the Piedmont has been cut through by streams, the valleys of which give the area a gently rolling surface. The drainage varies with the elevation. On the higher situations the soil is well drained and inclined to be droughty. The subsoil is always more retentive of moisture than its texture would indicate, while along the lower slopes it is clammy and frequently quite impervious to water. In the immediate vicinity of the Coastal Plain boundary the drainage is very good and a favorable moisture supply is maintained throughout the year. As a whole, however, the type is improved by artificial drainage.

The Cecil sand owes its origin to the weathering of granite and gneiss. The granite, a gray, medium-grained variety, contained considerable quartz. The close resemblance of the parent gneiss to that giving rise to the Cecil sandy loam suggests that the difference in these types, which is here chiefly in depth of soil and color and texture of subsoil, is largely accounted for by a peculiar retardation of drainage, aeration, and subsequent weathering in the subsoil of the Cecil sand. The soil in most cases is deeper where the underdrainage is good.

On account of the open nature of the surface soil and the consequent rapid leaching of fertilizers, together with the generally unfavorable condition of the subsoil, the Cecil sand is not naturally a productive soil and is not susceptible of rapid improvement. It is used, however, for general farming. Tobacco yields from 500 to 800 pounds per acre. Crimson clover and cowpeas afford yields of a ton or more of good hay per acre. Very little vegetable matter is turned under, and until more organic matter is incorporated in the soil by plowing under green or matured leguminous crops or by the addition of barnyard manure, little improvement in the type can be expected. While not especially well adapted to grass, sufficiently good stands can be secured to maintain a very beneficial crop rotation, similar to that practiced on the Cecil clay and the Cecil sandy loam. It would seem advisable to plow under pea vines in the fall, rather than to allow them to remain through the winter as a cover crop. Near the Coastal Plain boundary very fair crops of grain, corn, and grass are produced.

The following table gives the average results of mechanical analyses of samples of the Cecil sand:

Mechanical analyses of Cecil sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14141, 14143	Soil	2.3	11.5	8.7	31.4	18.6	21.7	5.4
14142, 14144	Subsoil	3.3	10.3	7.4	30.3	17.8	17.6	13.2

NORFOLK SANDY LOAM.

The soil of the Norfolk sandy loam to a depth of about 8 inches consists of a gray, loose, and incoherent medium sandy loam, underlain to an average depth of 18 inches by a pale-yellow, more compact material containing more fine sand. The subsoil is a yellow sandy clay which is inclined to be friable where the drainage is good, and clammy and sticky in the poorly drained areas. The constituent sand is more rounded than that of the Cecil soils, but owing to lack of fine material it is more distinctly harsh. A small percentage of rounded gravel occurs throughout the soil profile. At a depth of from 20 to 30 feet there usually occurs a stratum of material containing considerable coarse sand and gravel.

The Norfolk sandy loam occupies about one-half of the total area of the Coastal Plain region of Hanover County. It adjoins the Cecil sandy loam and the Cecil sand areas along the Piedmont-Coastal Plain boundary in a continuous body, except for the interruptions of small areas of Meadow and of Norfolk gravelly loam. The largest bodies of the type occur in the eastern part of the county. It occupies the most rolling areas of the Coastal Plain, including practically all of the steep valley slopes, some of which rise 100 feet or more within a half mile of the stream. In the eastern and southern parts of the county the surface is very rolling. There are some interstream plateau areas that have an undulating to gently rolling surface. Areas of the type are also found in narrow marginal strips along the flat bottom lands of the Pamunkey and Chickahominy rivers. On account of its sandy texture, open structure, and rolling surface nearly all of the Norfolk sandy loam is well drained, and a considerable proportion of it is so low in organic matter content and so open textured that crops suffer seriously from drought. The soil in some of the plateau areas could be improved by better drainage. The spongy nature of the soil prevents washing, the rain water being absorbed as rapidly as it falls.

The Norfolk sandy loam owes its origin to the deposition of material washed from the Piedmont during the submergence of the Coastal Plain. The heavier subsoil represents that part of the material laid down in comparatively deep water, while the soil owes its sandy nature in part to tidal and wave action during shallow-water stages of the uplift. There seems to have been but little modification of the material since the final uplift, except the removal of the finer particles along the slopes.

There are some local variations in the type. In a marginal strip west of Ashland the soil is shallow and contains enough fine material to impart a loamy character closely resembling that of the contiguous Cecil sand. This phase of the type is better adapted to grain and grass than is the typical light soil. As a result of erosion the soil of the steeper valley sides is more open textured and coarser grained and is often gravelly. Here the excellent drainage and the better circulation of soil atmosphere have brought about oxidation and dehydration of the underlying material, resulting in a red-colored and friable subsoil. This phase of the type, particularly those slopes receiving the most sunshine, seems to be especially well adapted to early vegetables, apples, peaches, and small fruits. Between Polegreen and Old Cold Harbor occurs a very light phase, occupying a position somewhat higher than the surrounding country. Here the soil to a depth of from 8 to 15 inches closely resembles the Norfolk sand. Below this is a pale yellow to reddish, slightly compact material containing more fine sand, which is underlain by a reddish-brown sticky sand or very light sandy loam, which may be 40 feet or more deep. The subsoil is so open that wells frequently run dry during droughts. The soil, however, maintains moisture remarkably well, considering its texture, and is the best early truck soil of the county. It is well adapted to cabbage, mustard, turnips, watermelons, cantaloupes, tomatoes, sweet corn, squash, sweet potatoes, lettuce, etc. The melons and sweet potatoes have a wide reputation for their fine quality and are shipped in large quantities. The potatoes are especially prized for their peculiar, dry, mealy characteristics and sweet taste. This phase of the Norfolk sandy loam is not sufficiently retentive of moisture for general farming, although sorghum, cowpeas, and oats and timothy give fair yields of hay. The native crab grass flourishes on this phase.

The Norfolk sandy loam has been cultivated for many years with but little attention to crop rotation. Large quantities of commercial fertilizers are used, particularly on the light trucking phase. They are applied in conjunction with stable manure at the rate of from 400 to 800 pounds per acre for cabbage, and about 400 pounds for sweet potatoes, melons, and a few other truck crops.[a] That the soil is naturally deficient in organic matter is generally recognized, yet there has been little effort made to improve it in this respect. Cowpeas and crimson clover plowed under green would prove very beneficial to this soil, increasing both its productiveness and its moisture-retaining capacity. As a rule the soil should be plowed deep and the depth of furrow varied from year to year so as to avoid the formation of a plow sole.

Corn, the leading crop, yields on an average 10 to 15 bushels per acre, although yields of 30 or more bushels are secured under good cultural methods. Wheat, oats, and mixed grasses give from poor to fair yields. Cowpeas, crimson clover, and sorghum with cowpeas can be grown with profit.

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[a] A study of the manurial requirements of a sample of this type of soil was made in the Bureau laboratories. The field from which the sample was taken has been under cultivation for a century or more with but little fertilization, and yet the yields are at present fair. The results of the tests indicate that the soil shows greatest improvement where applications of barnyard manure or a complete mineral fertilizer was used. Nitrate of soda alone gave results indicating some improvement in the soil conditions, but the other ingredients, sulphate of potash and acid phosphate, produced little or no effect, either when used singly or together. The tests with lime showed a small beneficial effect when it was used alone, but when added with the complete fertilizer lime seemed to have little or no effect. These results, which were secured with wheat plants as an indicator, are held to be strictly applicable only to that and allied crops, and then only on areas of the Wickham sandy loam in a condition similar to that of the field from which the sample was taken. They may, however, prove suggestive to farmers desiring to make field experiments along this line.

The following table gives the average results of mechanical analyses of fine-earth samples of the Norfolk sandy loam:

Mechanical analyses of Norfolk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14167, 14169	Soil	1.0	14.7	14.1	35.5	13.0	14.1	6.6
14168, 14170	Subsoil	.7	8.3	10.9	34.0	12.7	14.7	18.5

NORFOLK FINE SANDY LOAM.

The soil of the Norfolk fine sandy loam to a depth of about 6 inches consists of a gray fine sandy loam, passing into a yellowish compact but friable material of approximately the same texture, extending to a depth of about 18 inches. The subsoil is a yellow or bright yellow friable or slightly clammy fine sandy clay, sometimes underlain at from 20 to 30 inches by a coarse sandy material, frequently quite gravelly. It is very retentive of moisture. The soil in Hanover County is somewhat heavier than the type as found in other areas, containing more fine and very fine sand.

The Norfolk fine sandy loam occurs in irregular-shaped areas of varying extent throughout the Coastal Plain section of the county. The largest single area extends from Ashland southeast to a little beyond Newmans and Studley. This soil body is interrupted by areas of Leonardtown loam and is ramified by arms of Norfolk sandy loam wherever important streams pass out of it. The type mainly occupies level or gently rolling interstream uplands. It is always quite retentive of moisture. In the more nearly level areas farthest removed from streams the soil is shallow and of a heavier texture and is underlain by a bright yellow or mottled, poorly drained subsoil. In the vicinity of Studley and Ruel are extensive areas of a very flat, compact, pale yellow soil, which blends at a depth of about 10 inches with the subsoil without any distinct line of demarcation. Here the prevention of aeration, through inadequate drainage, has contributed to the unyielding nature of the subsoil and indirectly to the unproductiveness of the soil. The bad results of this poor drainage are in striking contrast to the productiveness of the soil in the more rolling, well-drained areas near streams or contiguous to areas of the Norfolk sandy loam. Occasional small areas of this phase, having a quite impervious nature, have washed and gullied, giving rise to unmanageable, unproductive spots having the characteristics of "galls."

The Norfolk fine sandy loam owes its origin to marine deposition of materials washed down from the Piedmont. There has been probably very little modification in the type since its uplift above the ocean.

This soil type, while only moderately productive in its natural state, is so susceptible of improvement where well drained as to warrant its recognition as the best general farming soil of the Coastal Plain uplands. In the neighborhood of Hanover the recent inauguration by several farmers of a system of more thorough soil preparation, in connection with rotation of grains with legumes and grasses and the turning under of leguminous crops, has demonstrated the worth of this soil type. Here yields of more than 40 bushels of corn, 25 bushels of wheat, 50 bushels of oats, and 1 ton of hay per acre are obtained. There is reason to believe that the type as a whole, with good artificial drainage where needed, can be made to produce similar yields. As has been demonstrated here, plowing for corn should be from 9 to 14 inches deep, and for wheat at least 8 inches, with subsequent thorough pulverization by repeated harrowing, disking, and rolling if necessary. While rolling is of value in securing good soil condition, it should not generally follow the drilling of grain or grass, since it destroys the ridges which tend to lessen the evil effects of heaving, which is a source of considerable damage to these crops, particularly on the heavier phases of the type. Commercial fertilizers are generally used by the best farmers. These are applied at the rate of about 200 to 400 pounds per acre.

While the Norfolk fine sandy loam is not so well drained and therefore not so warm or early a soil as the lighter Norfolk sandy loam, the larger yields of both trucking and general farming crops on the better drained areas, coupled with the more lasting effects of manures, more than offset the advantages of the latter type. The deep, very fine sandy loam in the vicinity of Atlee is especially well adapted to medium and late truck. Cabbage, tomatoes, melons, sweet potatoes, cucumbers, and squash constitute the principal crops. Good yields of wheat, corn, and hay are secured, and these should be grown as a regular part of the crop rotation.

The poor yields produced on the farms in the flat, poorly drained areas can not be increased until a good system of artificial drainage is established. Open ditches 6 to 10 feet deep were seen to have a beneficial effect upon a considerable width of contiguous soil. The distance between the ditches must be determined by field tests. Tiling would greatly benefit these areas, but its cost, in view of the abundance of cheap, well-drained land, practically forbids its use.

The following table gives the average results of mechanical analyses of samples of the Norfolk fine sandy loam:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14173, 14175......	Soil........	0.4	3.6	5.5	28.4	26.2	27.9	7.8
14174, 14176......	Subsoil.....	.4	3.0	4.5	24.0	20.2	24.8	23.0

WICKHAM CLAY LOAM.

The soil of the Wickham clay loam to a depth of about 6 inches consists of a pale yellow clay loam or gray very fine sandy loam, passing into a yellow clay loam which extends to a depth of 12 inches. The subsoil varies from a slightly friable to a stiff yellow, olive, or mottled silty clay containing considerable fine sand and numerous very minute flakes of mica in its lower depths. If undisturbed for a few months the soil assumes a compact structure which, however, readily changes to a good tilth when cultivated under favorable moisture conditions. The structure and color of the subsoil vary with the drainage conditions. Near Wickham, where the drainage is fairly good, the subsoil is yellow and uniformly compact, though fairly friable, while in the areas north of Oldchurch, where the drainage is not so good, the subsoil is distinctly mottled, compact, and somewhat brittle. The soil of those areas northeast of Oldchurch is deeper and contains more fine sand, while the subsoil has a dull olive color. There are a few irregular strips of a dark heavy clay, representing former swampy conditions, occurring in local depressions. Numerous small areas have such a shallow soil that the yellow subsoil is turned up when the fields are plowed, thus giving them a spotted appearance.

The Wickham clay loam occurs in small areas along the Pamunkey River, where it occupies level or gently undulating first and second terraces. The type owes its origin to the deposition of erosion material in comparatively quiet water during late Pleistocene time. While it is obvious that the type is composed in part of materials of the Norfolk soils intermingled with those washed down from the Piedmont, the clay content probably has been derived largely from outcrops of the Chesapeake formation. The drainage is exceptionally good for so heavy a soil, but open ditches are beneficial and even necessary in some of the flat or slightly depressed areas.

The soil is plowed generally to a depth of from 8 to 10 inches. If the depth is varied from year to year the formation of a hardpan that sometimes results from the smoothing of the plow and the trampling of the horses is avoided. After grazing, very hard clods are turned up when the land is plowed.

The Wickham clay loam is a very productive soil. It yields in good seasons from 40 to 60 bushels of corn, from 15 to 30 bushels of wheat, 50 or more bushels of oats, and from 1 to 2 tons of hay per acre. Very little grass is grown, however, except for pasturage. Many farmers follow wheat or oats with corn for one or more years and then sow the land in grass for grazing. Commercial fertilizers are coming into general use on this type. With more careful management this soil can be made to produce larger yields. To increase its productiveness more seasonable cultivation, the plowing under of leguminous crops, and avoiding grazing in wet weather are recommended.

The following table gives the average results of mechanical analyses of samples of the Wickham clay loam:

Mechanical analyses of Wickham clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14191, 14193	Soil	0.8	3.4	4.5	27.3	24.7	22.2	16.4
14192, 14194	Subsoil	.3	1.4	2.6	15.9	21.8	24.3	33.7

WICKHAM SANDY LOAM.[a]

The soil of the Wickham sandy loam, to a depth of from 10 to 26 inches, consists of a brown or reddish-brown loamy sand to friable mellow sandy loam. The surface appearance of much of the type is that of a sand, but closer examination reveals a very intimate mixture of about equal parts of clay, silt, and the various grades of sand, imparting to the soil decided loamy characteristics despite a high total sand content. The subsoil is a reddish or reddish-brown sandy loam, or sometimes sandy clay, containing minute scales of mica. At a depth of from 30 to 50 inches the subsoil passes into a stratum of very coarse sand and medium gravel or into a quite porous coarse sandy to medium gravelly loam. Like the other light soils of the terrace formation, the Wickham sandy loam maintains an inherent loaminess, even under continuous cropping, without the addition of manure. About one-half the area mapped may be described as a slightly heavier phase, and this is considered a rather better soil for general farming.

It occurs in many small areas occupying terraces generally adjacent to the North Anna and Pamunkey rivers or the overflow land. The surface is level or nearly so, a fact accounted for in part by the sudden drop from one terrace to another. The soil is open, well drained, and easily tilled under a wide range of moisture conditions. While crops are apt to suffer to some extent during protracted droughts, damage from this source is never serious.

The type represents materials of the original Coastal Plain, for the most part the Norfolk sandy loam reworked and intermingled with small quantities of wash from the Piedmont and deposited in recent Pleistocene time. The prevailing red color is the result of the intimate mixing with red Cecil soils and thorough oxidation of the iron components.

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[a] Wire-basket tests on a sample of this type of soil taken from a "wornout" field showed that it responded best where applications of barnyard manure or of a complete mineral fertilizer with lime was used; that nitrate of soda, alone or in combination with another salt, gave a fair increase in productiveness; and that sulphate of potash alone produced some improvement in the soil conditions. On the other hand, lime alone and acid phosphate, alone or in combination, seemed to be without effect. These results were secured with wheat as an indicator and are held to be strictly applicable only to this and related crops, and only on areas on this soil that are in a condition similar to the field from which the tested sample was secured.

The Wickham sandy loam is a very desirable soil for general farm crops. Because of its good circulation of soil atmosphere and its excellent drainage it is adapted to the production of early truck, but its suitability for this purpose is somewhat impaired because of the chilling effects of the colder atmosphere that settles in the river valleys during the night. The principal crops grown are corn, wheat, oats, grass, and sweet potatoes. Upon the more loamy or heavy phase of the type the yields of corn range from 30 to 60 bushels, wheat from 15 to 25 bushels, and oats 30 to 50 bushels per acre. Grass and forage crops are grown for grazing and for fattening cattle. A mixture of sorghum and cowpeas makes yields of from 1 to 3 tons or more per acre of very good hay. General farming should give way, at least in part, to a more specialized system, including the cultivation of potatoes and certain medium and late truck crops, as cabbage, beans, tomatoes, etc.

Walnut and locust form a part of the characteristic timber growth of this terrace soil. In its higher situations the type is well adapted to the production of apples.

The following table gives the average results of mechanical analyses of this type of soil:

Mechanical analyses of Wickham sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13697, 14181, 14183, 14185	Soil	2.2	16.1	15.5	23.5	13.6	16.8	12.0
13698, 14182, 14184, 14186	Subsoil	1.5	13.0	14.3	21.2	10.9	15.7	23.2

WICKHAM SAND.

The soil of the Wickham sand is a dark-brown to yellowish-brown coarse sand, from 16 to 26 inches deep, generally coarser in texture and lighter in color below 14 inches. The subsoil, a reddish-brown or yellowish, loose, incoherent sandy loam, becomes lighter in color with depth and is underlain at from 28 to 40 inches by a decidedly coarse gravelly material similar to that underlying the Wickham sandy loam. While the type carries a high percentage of coarse sand and medium and fine gravel, the soil, owing to peculiar structural arrangement of the component particles, tends to preserve its original loamy characteristics. The surface 5 or 6 inches, when undisturbed by cultivation, assumes a compactness which apparently is due both to the settling and packing effects of rains and to a tendency of the finer particles to adhere or cling to the coarser ones. Some areas were observed where there was more fine material in the surface soil than was contained in the soil a few inches beneath. However, with continued cultivation a large proportion of the finer particles have been washed out of the soil of a considerable percentage of the type, leaving a very unproductive coarse sand. Along the lower course of the Pamunkey River the type is underlain at from about 15 to 20 feet by greensand marl.

The Wickham sand is found along the lower course of the North Anna River and along the Pamunkey River in small, widely separated areas, where it occupies first terraces which are level or have an almost imperceptible slope toward the river. It has no definite occurrence with relation to other types, but it occurs in areas more or less semicircular in shape and generally occupies the concaves of bends abutting the river or overflow land. The drainage is good, and the coarser phase is inclined to be droughty. The water table lies at about 5 feet below the surface. Wells with a depth of 10 feet give a plentiful supply of water, even in dry seasons.

The soil was laid down in Pleistocene time by rapidly moving water, and represents reworked Coastal Plain and Piedmont materials.

Nearly all of the Wickham sand is cleared and has been under cultivation at one time or another for probably more than seventy-five years. Considerably more than one-half the type is very desirable for farming purposes, particularly for the production of cowpeas, forage crops, and hay, in connection with stock raising or the fattening of cattle. The better areas are capable of producing from 30 to 40 bushels of corn, 10 bushels of wheat, 10 bushels of peas, and from 1 to 1½ tons of hay per acre. The hay consists of pea vines or grass mixtures, generally including crimson clover, timothy, orchard grass, and tall meadow oat grass. Cowpeas furnish excellent grazing. For the growing of corn and wheat commercial fertilizers are sometimes used at the rate of about 300 pounds per acre. Crimson clover sown with rye is sometimes plowed under after spring grazing.

Cowpeas constitute the chief crop grown on the less productive phase. A yield of 5 to 8 bushels per acre is considered good. The little expense attached to the cultivation of peas, coupled with recent good prices, makes this a fairly profitable crop. They are sown broadcast or on ridges. Large yields of hay are occasionally produced on land that makes less than 10 bushels of corn per acre. Mixtures of orchard grass, timothy, tall meadow oat grass, and crimson clover afford good grazing. Wire grass flourishes on this soil. This last phase is considered poor land, and applications of manure have but temporary effect on it.

The following table gives the average results of mechanical analyses of samples of the fine earth of the Wickham sand:

Mechanical analyses of Wickham sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14157, 14159, 14163, 14165...........	Soil.........	7.1	30.8	12.4	16.7	13.0	10.6	9.2
14158, 14160, 14164, 14166...........	Subsoil.....	6.3	27.8	13.4	18.9	13.0	10.2	10.2

NORFOLK GRAVELLY LOAM.

The soil of the Norfolk gravelly loam as typically developed consists of a dark-gray medium gravelly loam, grading at about 8 inches into a yellowish material containing more sand and less gravel. This is underlain, generally at a depth of 20 inches, by a yellowish coarse sandy loam containing comparatively little gravel, or by a reddish coarse sandy clay carrying considerable coarse and medium gravel. The gravel represents rounded quartz pebbles rarely exceeding three-fourths of an inch in diameter, while the sand, for the most part of medium grade in the surface soil, becomes coarser with depth.

The type is confined mainly to stream slopes near the Piedmont-Coastal Plain boundary and consists largely of materials remaining after severe erosion of sloping areas of the Norfolk sandy loam. The soil depth varies with position and angle of the slope. Along the base of the slopes it may consist of a heterogeneous mass of gravel and sand, while near the summit it may consist almost entirely of gravel.

Most of the type has been cleared and under cultivation at one time or another. Its occurrence in small sloping areas, together with its extreme droughtiness and unproductiveness, renders it practically a nonagricultural type of soil. Several areas in the neighborhood of Doswell and one near Farrington which occupy gentle slopes produce small yields of corn. Here the soil to a depth of 24 inches is a uniform gravelly loam with considerable fine interstitial material.

The following table gives the average results of mechanical analyses of the fine earth of this type of soil:

Mechanical analyses of Norfolk gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14187, 14189......	Soil.........	6.9	19.4	18.8	21.1	6.8	19.0	7.7
14188, 14190......	Subsoil.....	8.7	27.5	13.4	17.4	4.6	8.0	20.2

LEONARDTOWN LOAM.

The soil of the Leonardtown loam to a depth of from 3 to 8 inches consists of a grayish to dark-colored, rather heavy, very fine sandy loam. The average depth is about 4 inches. The subsoil is a deep yellow to mottled brown and bluish fine sandy clay, passing at about 2 feet into a clammy mottled clay. The soil of the poorly drained flat areas is frequently black or dark colored and is very similar in texture to a clay loam, while the subsoil is very clammy and is mottled with yellow and steel-blue colors. Below 30 inches the subsoil not infrequently has a puttylike consistency, even in very dry spells. Notwithstanding the variation in color and structure, the textural differences are not pronounced. In the neighborhood of the North Anna-Pamunkey River escarpment the soil consists of a grayish very fine sandy loam 5 to 9 inches deep, underlain by a heavy, massive, mottled yellow and brown clay extending to a depth of 20 feet or more. Where this heavy clay is exposed in the deep gorges indenting the type along the rim of the escarpment it cracks in a manner resembling jointed clay.

The Leonardtown loam is confined almost entirely to a narrow belt lying between the Piedmont-Coastal Plain boundary and a north and south line drawn about 6 miles east of Ashland. While the areas are irregular shaped and widely separated, they conform rather closely to a definite topographic position, namely, the interstream plateaus corresponding to the poorly drained areas described under the Norfolk fine sandy loam. The largest area is in the vicinity of Ashland. Small patches of the Norfolk fine sandy loam, too limited in extent to be shown upon the map, have been included with this type.

The surface of the Leonardtown loam is gently undulating, flat, or slightly depressed. Continued wet weather brings about a marshy condition in the poorly drained locations, and the higher lying areas, though apparently firm, become very miry. The subsoil remains cold and wet until late spring, even after crops on other soils are suffering for lack of moisture, and because of the shallowness of the soil plowing is delayed until late in the season. However, when the soil once gets into a cultivable condition very little trouble is experienced during the growing season, provided the rainfall is not above normal. In those areas north of Ashland where the heavy subsoil comes near enough the surface to be turned up with ordinary plowing very intractable clods are formed.

The type owes its origin to depositions in comparatively deep water. Since its uplift above the sea very little modification has taken place. It is very deficient in both surface and underdrainage; hence weathering has been restricted to a very few inches of the surface soil. There is practically no erosion, except in areas bordering the bluffs.

About three-fourths of the type supports a thick growth of stunted pine, hickory, and oak. This soil is recognized as being naturally the most unproductive, as well as the most difficult to improve, of all the upland soils. The effects of manures are not lasting. Poor drainage and the cold, stubborn nature of the subsoil tends to retard the development of root systems and check the growth of the plants. Yields of from 5 to 15 bushels of corn per acre are made occasionally, and on the better drained areas fair yields of oats, wheat, and moderate stands of orchard grass, herd's-grass, and crimson clover are sometimes secured. Drainage by deep open ditches, placed at intervals best determined by field tests, would put this soil in a condition to produce at least moderate yields of a great variety of crops. On the dark phases drained by open ditches good crops of wheat and grass were seen growing. Much of the type should not be cultivated until better drainage is secured.

The following table gives the average results of mechanical analyses of this type:

Mechanical analyses of Leonardtown loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14197, 14199	Soil	1.4	6.8	5.2	21.3	19.4	27.2	18.6
14198, 14200	Subsoil	.9	6.2	4.9	17.9	17.9	22.7	28.9

SWAMP.

In Hanover County Swamp comprises the low-lying areas along the lower North Anna and Pamunkey rivers, which are subject to annual inundations, and nearly all the overflow land of the Chickahominy bottoms included in the Coastal Plain.

The Swamp areas of the North Anna and Pamunkey are repeatedly covered in the spring and summer by deep floods carrying in suspension material brought down from the Piedmont. The soil consists largely of a deep chocolate-colored silty clay, which is generally wet the year around. The surface is inclined to be ridgy or hummocky. The small intervening depressions are merely ponds of water during wet seasons, which dry up during the summer and support a luxuriant growth of water-loving plants, the remains of which form thick deposits resembling muck. These Swamp lands support a thick growth of heavy timber, consisting principally of gum, tulip or poplar, pine, and beech. Not infrequently the ridges support a growth of holly.

The Swamp areas of the Chickahominy River represent an almost continuous strip, varying in width from a few rods to one-half mile. On account of the small extent and sandy character of the drainage basin the overflow water is never as muddy as that of the North Anna and Pamunkey rivers. The soil varies from sandy loam to clay loam. It is generally wet and is entirely covered by a dense growth of small size gum, tulip, birch, and beech.

None of the Swamp is under cultivation. Because of its low-lying position and the annual overflows crops would be very uncertain.

MEADOW.

The Meadow of the Piedmont region consists usually of 2 or more feet of dark-colored soil varying from sandy loam to silt loam. It occurs in narrow strips of level bottom lands or terraces along nearly all the streams. The texture of the soil along the lesser streams depends upon the character of the soils of the respective drainage basins. Much of the Meadow in the upper courses of these small streams simply represents soil, frequently of residual origin, which, through seepage, is kept too wet for cultivation. The Meadow contiguous to large streams is usually a clay or silt loam composed largely of materials transported a considerable distance and laid down in time of overflow. The most extensive areas occur in the concaves of bends, the convex sides of which are generally more or less precipitous.

Probably 50 per cent of the Meadow areas west of Ashland have been drained and put under cultivation. The type is especially adapted to corn, producing about 50 bushels per acre year after year without the use of fertilizers. Oats or grass, particularly wild or native species, do well. The uncultivated part of the type is covered by a dense growth of water-loving plants and trees.

The Meadow of the Coastal Plain consists of narrow bands of sandy material generally too wet for agricultural purposes. It is not being built up nearly so rapidly as in the Piedmont for the reason that the surface flow-off is much less rapid and the soil constituents are too coarse for ready transportation. The open soil absorbs a considerable proportion of rainfall and liberates it gradually. On the deep-stream valleys the water of the numerous perennial springs in the base of the exposed gravelly substratum underlying the soil keeps the bottom land nearly saturated the year round.

In the neighborhood of the Piedmont Coastal Plain boundary the Meadow land becomes quite narrow, until it disappears along the streams flowing through gorgelike channels.

Meadow is a very uncertain type for crops on account of the danger of overflow. However, crops planted after the usual spring inundations are not often destroyed. By straightening channels and removing obstructions a large part of this productive bottom land could be brought under cultivation.

AGRICULTURAL METHODS.

Hanover County comprises practically three agricultural provinces, having essentially different agricultural methods to fit the differences in soil texture, crop adaptation, and physiographic features. The Piedmont division is characterized by general farming and tobacco growing, the Coastal Plain highlands by general farming and trucking, and the North Anna-Pamunkey River escarpment by general farming and the fattening of stock.

In the Piedmont a general adherence to some form of crop rotation, as well as the improving of methods and the systematizing of farm operations, has done much to maintain the productiveness of the soil. In the general scheme of crop rotation wheat is followed by a crop of cowpeas or a grass-clover sod for two or three years, then either by a crop of tobacco or corn, or by corn succeeding tobacco. Farmers generally are averse to cultivation of corn before tobacco, but with fall plowing and heavy manuring instances have shown the practice to be commendable, since the clean cultivation is very destructive to insect pests. Cowpeas and crimson clover should have a place in the rotation whenever possible. The former are often sown broadcast between corn rows at the last plowing, while crimson clover is frequently sown with rye in the fall, grazed in the spring, and turned under preceding a crop of corn. The latter practice finds favor throughout the area. While diversity of opinion has led to minor alterations in the above plan, its adaptability to prevailing conditions can not be well questioned. Considerable injury, however, arises from too close grazing of grass lands, not only here but throughout the county. It is claimed that the best results from cowpeas are to be had either by plowing them under after maturity or allowing them to remain through the winter as a cover crop, serving as a mulch. This last practice as a means of maintaining a good water supply and soil structure has displaced to a marked extent fall plowing. The prejudice against turning under green manures undoubtedly would be overcome on the Cecil and some of the heavier Norfolk soils if the practice were supplemented by judicious applications of lime and by growing winter crops of grain. Barnyard manure is generally carefully saved, but so little is produced that it is necessary to supply other kinds of manure or fertilizers. Considerable commercial fertilizers are used for general farming purposes, usually in the form of acid phosphate or special brands analyzing approximately 8 per cent phosphoric acid and from 1 to 2 per cent each of potash and nitrogen. Applications are made at the rate of about 150 pounds and from 300 to 500 pounds per acre sown in the rows for corn and tobacco, respectively, and 300 pounds per acre sown broadcast or in drills for grain. The grades of fertilizers are better and the applications per acre much heavier in the trucking districts. It is generally conceded that mineral fertilizers are far more beneficial when used in conjunction with organic manures. The cheaper practice of home mixing of concentrated fertilizer ingredients is earnestly recommended.

Corn and tobacco are cultivated on ridges pretty much on the same plan. When the plants are large enough, shallow furrows are run close up on both sides of the bed with a turning plow or small shovel, which throws a part of the bed toward the middle of the row, leaving the plants on sharp ridges. For later cultivations larger, deep-set plows are used to run several furrows between the rows, until finally the entire middle is thrown out and the plants are left on high ridges separated by deep, gutterlike furrows. Grass and weeds are removed from between the stalks by repeated hoeings, during which soil is frequently heaped around the stalks so as to form a small hill. The ridges bring the root system nearer the baking effects of the sun and at the same time increase the surface area exposed to evaporation, while the deep inter-ridge cultivation not only breaks up the surface root system, but also leaves a furrow that serves the purposes of a ditch in collecting and carrying off a large proportion of the rainfall. This disadvantageous system should be replaced by a more nearly level cultivation, with the use at frequent intervals of harrows, shallow-toothed cultivators, and lighter plows, following deep initial preparation of the soil.

Tobacco is cut and placed directly in well-ventilated barns for air curing or is scaffolded in the sun for several days if the weather permits, and is then placed in the barn.

Truck farmers buy large quantities of stable manure at Richmond, hauling it not infrequently 20 or more miles. Heavy applications of this manure are made on the light truck soils.

While the Coastal Plain upland soils generally should be plowed deeper, their primary need is increased organic matter content. Green manuring seems much more appreciated here than in the Piedmont, yet far too few crops are turned under. The poorly drained areas of the Norfolk fine sandy loam and the Leonardtown loam are not well managed, but there is no particular need of improved methods in the cultivation of these soils until better drainage systems are installed.

The large quantities of truck of inferior quality produced on the numerous rudely cultivated patches tend to weaken prices in the local market, thereby discouraging the efforts of the better truck farmers in the southwestern part of the area. In the trucking section between Atlee and Old Cold Harbor, where the cultural methods are well adapted to the local conditions, improvements are needed in the plan of marketing. Trucking is carried on more nearly on the market-gardening plan. Most of the truckers grow 1 or more acres of very early cabbage. The cabbage plants are set out in the fall, often as late as Christmas, and are wintered over so as to have an early start in the spring. The only protection offered them is the ridges between which the plants are set, yet they are rarely damaged by cold weather.

Tomato plants grown under glass, when transplanted without detaching the soil enveloping their roots, make a rapid growth on the light phases of the Norfolk sandy loam and Norfolk fine sandy loam. By topping and suckering, a heavy fruitage of large tomatoes of excellent quality is secured. Sweet potatoes are often "hilled up" in the field, being piled up and covered with straw and soil, one or more small openings being provided for ventilation. It frequently happens that the potatoes rot in large quantities if not well dried before hilling.

Owing to favorable texture and structure of the soils, the level surface and good natural drainage without danger of washing, thorough methods are practiced in preparing the bottom lands along the North Anna and Pamunkey rivers. Here the preparation of the land includes plowing to a depth of from 8 to 14 inches and frequent harrowing and rolling. Grain and grass are nearly always drilled in, and in some instances rolled to prevent heaving. Spring rolling to firm the grain land puffed by the action of frost would prove beneficial not only on these lowland soils, but probably on all soils of the area.

Corn is either cut in the stalk and shocked or else allowed to remain on the stalk until late in the fall, when it is pulled off and hauled to the barn. Large quantities of fodder are ruined by the weather when planting is done so late that the grain can not mature until after frost, because of the scarcity of labor and the consequent impossibility of "pulling the fodder." The remedy seems to be in early planting, so that the corn can ripen enough to be cut before the fodder is ruined by frost and rain. Corn is generally followed by wheat and occasionally by grass. It is the plan of the best farmers to turn under cowpeas and crimson clover before planting wheat and corn. Recently the raising of hogs for market and fattening cattle driven from Richmond has become an industry of some importance. Instead of fattening cattle driven in from Richmond, it would seem that raising the stock at home would prove more profitable. In this connection large quantities of cowpeas and mixed grasses are grown for grazing purposes. The land does not seem to be injured seriously by close grazing.

Thrashing, husking, and shredding of corn, and the manufacture of sorghum sirup are done largely by traveling outfits, the owners of which are paid generally by toll.

Because of a recent scarcity of labor, modern agricultural methods and labor-saving machinery are being forced upon the farmers in this region, their adoption being much more rapid than would have been the case with an abundance of cheap labor at hand.

As a rule, the soils are tilled with little difficulty, although in the areas of the Cecil clay and Wickham clay loam many intractable spots are found that can be managed and properly cultivated only under favorable conditions of soil moisture. The chief problems of soil management are those relating to better drainage in certain of the types—as the Norfolk fine sandy loam and the Leonardtown loam—more thorough soil preparation, and the incorporation of more organic matter in the soil. While the larger proportion of grain is drilled in, there still prevails the faulty practice of seeding by hand, whereby poor stands are secured and more damage is done by heaving, especially on heavy soils.

AGRICULTURAL CONDITIONS.

Hanover is strictly an agricultural county. There are no large towns, and aside from sawmills and gristmills there are no manufacturing industries. The area affords an interesting example of conditions resulting from a close adherence to conservative methods over a long period of time. While farming operations have been carried on since early colonial days, on a variety of soils ranging from poor to very productive, and embracing a wide crop adaptation, the farmers, as a rule, have done little more than make a comfortable living. The scarcity of money and disorganization of labor during the period immediately following the civil war necessitated the abandonment of a large acreage of cultivated land, much of which now supports a heavy growth of old field pine. Plantations left to the care of tenants have deteriorated, while those operated by the owners have been kept in good condition in the majority of cases. The dwellings, many of which were built before the war, generally are quite substantial and some are handsome and commodious. Occasionally a silo is seen in the section adjacent to the North Anna-Pamunkey lowlands, where considerable attention is paid to stock raising. Barbed wire fences have been substituted for the old rail fences in many cases.

Notwithstanding the scarcity of labor, there are distinct evidences of progress and increased prosperity on many of the farms. Up-to-date farm machinery and the better methods of soil management have combined to increase the acreage yields, to stimulate diversification, and to make farms more generally self-sustaining. Tobacco growers, finding it impracticable to cultivate a large acreage of that crop, have extended the acreage of other crops. In the neighborhood of Rockville there are many instances where, in addition to the tobacco crop, a surplus of wheat, corn, and hay is produced. Indications are that this may be at an early date the rule rather than the exception throughout the tobacco district. A growing spirit of cooperation is evidenced in a recent organization of the tobacco growers for the purpose of securing better methods for handling and marketing the tobacco crop. The cultivation of the soils of the North Anna-Pamunkey Valley has generally proved quite profitable, yet some fine farms with excellent dwellings, intrusted to the care of overseers or tenants, have deteriorated greatly in value. The bottom lands are valued at from $15 to $40 an acre.

In the trucking district between Atlee and Coldharbor the farmers make a comfortable living, and some have accumulated considerable money. The dwellings and outhouses, though small, are comfortable and sufficient for general needs. Much of this trucking land is valued at more than $40 an acre.

The least degree of prosperity is shown on the farms situated on the Leonardtown loam and the poorly-drained areas of the Norfolk fine sandy loam. Here the land is cultivated in patches and the dwellings are very small.

The expenditures for commercial fertilizers in Hanover County have more than doubled in the past twenty years. While the acreage yield of wheat has not materially changed during this period, that of tobacco and corn has increased considerably. These increased yields are attributed to the general better plan of farming.

About 60 per cent of the farms are operated by the owners. This percentage is being increased through the purchase of farms by immigrants attracted by the equable climate and cheap land. Under ownership management expenses are light, purchases are paid for in cash, and very little land is encumbered.

Farm tenancy comprises two general systems; under the one the landlord furnishes land, stock, tools, and feed, and receives as his share one-half of the crops; under the other he furnishes the land and pays one-fourth of the fertilizer bill, and receives one-fourth of the crops. The tenant rarely pays any house rent or for fuel. The liberal opportunities thus afforded do not seem to have been appreciated generally, judging from the migratory disposition of tenants.

Farms range in size from about 25 to 500 acres, the average being about 105 acres. Though most of the large antebellum plantations have been divided among heirs, several holdings of 1,000 or more acres have remained intact. Quite a number of small farms are owned by colored people, particularly in the section about 6 miles southeast of Hanover. In the tobacco-growing district the average farmer generally cultivates 5 or 6 acres of tobacco, from 20 to 40 acres of corn, and about the same area in grain, grass, and other crops combined. Truck growers do their own work largely and cultivate from 10 to 30 acres, including general farm crops. The largest cultivated farms are those of the North Anna-Pamunkey bottoms, where, sometimes, 200 acres or more, including grass lands for grazing purposes, are tilled under one management.

As crop adaptation has been pretty well worked out the greatest developments must necessarily follow along the line of more intensive methods of cultivating crops now grown. It frequently happens, however, that a certain acreage of land is put in corn and grain year after year from force of habit, with but little attention paid to the suitableness of soils.

Hanover County and the neighboring counties of Caroline, Spottsylvania, Louisa, and Fluvanna produce the bulk of the Virginia sun-cured tobacco. The leaf produced in Hanover County is probably a little darker and coarser textured than the average. It is moderately oily and gummy, and as a popular chewing variety commands good prices. While some of the crop is cured partially in the sun, the greater part is cured from the beginning in well ventilated barns. There is but little difference in the color of the cured product. Most of the crop is sold unprized. The leaf grown on the newly cleared land has a finer texture and some of it makes excellent wrappers. The Cecil soils, including even the heavy Cecil clay, are admirably adapted to tobacco. The better quality is produced on the light soils, but the largest yields per acre are secured on the heavy types. Some very good crops are grown on the Norfolk sandy loam and Norfolk fine sandy loam in the neighborhood of the Coastal Plain-Piedmont boundary, but the bulk of the crop is produced on Cecil sandy loam and Cecil clay. The quality of the cured product depends largely upon the ability of the grower properly to manage the leaf after cutting.

Corn, wheat, and hay are grown on every soil type of the county, and outside of the tobacco and truck districts constitute the staple crops and everywhere enter the best rotations. Though every farm, with the possible exception of those situated on the light Norfolk sandy loam and the Wickham sand, could be made at least self-sustaining in respect to hay and grain for the farm stock, actual production too frequently falls short of this, notably on those upland soils growing other crops as specialties. The especial adaptation of the Cecil clay, Wickham clay loam, and Wickham sandy loam to corn, wheat, oats, and a variety of grass and forage crops is evidenced by the yields generally produced on these types. Almost as good yields can be secured from a large part of the Cecil sandy loam and Norfolk fine sandy loam by careful handling of the soil. The excellent yields of forage crops, particularly cowpeas and crimson clover, and the good winter and spring grazing afforded by rye and crimson clover, would make stock raising or dairying on a small scale profitable on some of the lighter soils not especially adapted to general farming.

The light Norfolk sandy loam and Norfolk fine sandy loam in the southeastern part of the county are well suited to market gardening and general trucking. Owing to limited market facilities, sharp local competition, and to a large quantity of inferior vegetables produced on poorly drained soils, sales of these crops are often made at unprofitable prices. The Norfolk sandy loam produces good nursery stock. Some of the heavy poorly drained soils could be profitably used for growing grasses, millet, or sorghum. Fruit receives too little attention. The Winesap and other varieties of apples flourish on the Cecil soils, although there has been considerable trouble in late years on account of the apples rotting and falling from the trees. Better success could be obtained by more careful cultivation and by the use of sprays and washes. Peaches and small fruits could be grown more extensively on the well drained sandy soils of the Coastal Plain.

The Chesapeake and Ohio and the Richmond, Fredericksburg and Potomac railroads afford good transportation facilities to the central and most of the western part of the county. Considerable quantities of forest products are shipped by boats that ascend the Pamunkey River to a point several miles northwest of Oldchurch. In the southeastern part of the county shipping is done over the Southern Railway to Westpoint and thence by boat to Baltimore. Richmond is the general market of the area. Some sweet potatoes and melons are shipped to other markets. An extension of the shipping of products to more or less distant markets, which is far short of what it should be in view of the good transportation facilities, affords about the only means for stimulating general trucking, but apparently little effort has been made toward widening the outside markets. The county roads in the Piedmont region become so miry in places during the winter and spring months as to be well-nigh impassable, while those on the light Norfolk sandy loam are very difficult to travel in dry weather. Road-making machines owned by the county are making considerable improvements.

SOIL SURVEY OF THE YORKTOWN AREA, VIRGINIA.

By R. T. AVON BURKE and ALDERT S. ROOT.

LOCATION AND BOUNDARIES OF THE AREA.

The area surveyed lies in southern tide water Virginia. It is bounded on the north by King and Queen, Middlesex, and New Kent counties; on the east by Mathews County and Chesapeake Bay, Mobjack Bay, and Hampton Roads; on the south by Hampton Roads and James River, and on the west by Charles City, New Kent, and King and Queen counties. It includes the counties of James City, York, Elizabeth City, Warwick, and Gloucester, comprising in all an area of about 598 square miles.

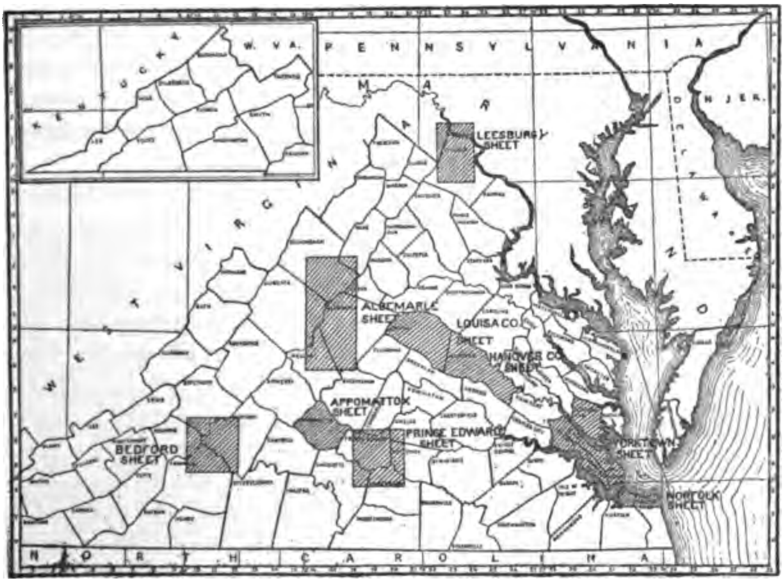

FIG. 8.—Sketch map showing location of the Yorktown area, Virginia.

The flourishing cities of Newport News and Hampton lie in the southeastern part of the area, while the historic towns of Williamsburg and Yorktown are also within the area. An extension of the Chesapeake and Ohio Railway crosses the area in a southeasterly direction.

A plane-table traverse of the entire area was made by the party in the field, a chart of the Coast and Geodetic Survey supplying most of the coast lines. All the public roads were plotted, but a number of secondary and private roads were omitted, only such being traversed as were necessary accurately to locate soil boundaries.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The Yorktown area is one of the earliest settled regions of the United States, being the site of the first permanent English colony, established at Jamestown in the southern part of the area in 1607—three hundred years ago. There were over a hundred members in the first expedition, and two years later 300 others arrived at Jamestown.

At first the lands of the colony were owned and worked in common, but during Sir Thomas Dale's administration anyone paying a certain nominal sum into the treasury became entitled to 100 acres of land, 3 acres of which he obligated himself to cultivate in "corn," bringing annually 2½ barrels of corn to the public granary. As a result of this system, instead of the deficiencies of supplies which characterized the early years, there was always a surplus.

In 1616 the colony numbered 351 persons, of whom 25 were women and children. They were well supplied with horses, cattle, sheep, and goats, and during this period began to build more substantial houses. As the settlement grew large tracts of land were brought under cultivation, mainly for the production of tobacco.

The first land grant in Gloucester County, which was formed in 1652 from Pamunkee, one of the original eight shires into which Virginia had been divided, was made in 1635 to Augustine Warner. Prior to this time the colonists in this part of the area had been very cautious in pushing into the wilderness beyond the protection of the older colonies. In 1642 other grants were made in Gloucester County and the settlers began to push across York River to develop what was afterwards (in the early part of the eighteenth century) the most prosperous and populous of the Virginia settlements. The settlers built rude houses, which were afterwards to give way to more pretentious structures, and the crops grown and the methods pursued here were the same as in the other settlements. The principal crops were corn and tobacco, which were grown in small patches on newly cleared land. Many of the methods of cultivation were copied from the Powhatan Indians, who originally inhabited this county, and from whom the settlers learned to use fish for fertilizer and to plant them in the hills of corn. The yields are said to have been much greater then than now, and it is reported by one writer that an acre produced as much as 200 bushels of corn, peas, and beans. John Rolfe began the first cultivation of tobacco in the area in 1612, having learned the method from the Indians. This crop afterwards became the chief product of the country and was used as a medium of exchange. To-day it is not grown in the area.

In 1650 there were upward of 1,500 people in this section of Virginia, and this number more than doubled in the next twenty years, largely the result of the execution of Charles I of England, which forced the Cavaliers to exile.

Jamestown was the capital up to 1699, when, owing to the unhealthy location of the town, Williamsburg, then known as Middle Plantations, became the seat of government. After the Revolutionary war it was again moved; this time to Richmond.

Prior to the Revolutionary war the development of the country had been slow though sure. During this struggle it came to a standstill, only to be renewed with increased vigor upon the return of peace. It was between this epoch and the beginning of the civil war that the country enjoyed its greatest agricultural development. It was then a great wheat-producing section, but the production of this crop almost ceased with the opening up of the western wheat fields. Tracts that were then under cultivation are now covered with forests of pine, and the old corn rows can still be seen in many places.

In 1881 the Chesapeake and Ohio Railway was built from Richmond to Old Point Comfort. Newport News was then only a small fishing town. It now has a population of over 19,000, while numerous other smaller towns have sprung up along the line of this railroad.

CLIMATE.

The climate of the Yorktown area is mild and equable, although changeable. The absence of extremes is particularly noticeable in the southern part of the area, as is evidenced by the fact that Newport News and Old Point Comfort are patronized both as summer and winter resorts. In the northern part of the area, as the distance from salt water and the altitude increases, the winters are slightly colder and the summers warmer. How much the proximity of the ocean and the neighboring waters modify the climate of the section can not be shown by actual records, but this is largely the cause of the freedom from early fall and late spring frosts in the tide water part of the area.

The annual precipitation ranges from 35 to 50 inches, an abundance for the needs of the crops. During the fall and winter seasons the rains are usually accompanied by easterly winds, which is true of the summer rains of long duration, the wind currents being easterly, particularly southeasterly, although thunder showers usually come from the west.

In the following table are given the temperature and precipitation as recorded by the Weather Bureau stations at Hampton, Norfolk, and Spottsville, the latter situated inland and to a less extent influenced by the proximity of bodies of water. The figures for Hampton and Norfolk show the conditions along the water front particularly.

Normal monthly and annual temperature and precipitation.

Month.	Hampton.		Spottsville.		Norfolk.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	*°F.*	*Inches.*	*°F.*	*Inches.*
January	41.9	2.51	38.2	2.77	40.4	3.83
February	40.6	3.88	39.4	3.99	42.3	3.85
March	48.5	3.68	46.0	4.81	46.9	4.59
April	55.5	3.45	55.8	3.21	56.2	4.07
May	65.8	4.22	66.5	3.31	66.4	4.28
June	75.2	4.10	74.5	3.28	75.1	4.23
July	79.3	5.59	78.1	6.09	78.5	5.92
August	78.0	4.44	75.8	4.99	76.6	6.11
September	71.5	3.20	69.9	3.41	71.1	4.56
October	60.6	3.69	57.8	4.10	60.6	3.87
November	49.5	2.75	48.2	2.72	50.3	3.10
December	42.2	3.07	40.7	3.17	42.8	3.67
Year	59.1	44.58	57.5	45.85	58.9	52.06

The average dates of killing frost for the same stations are as follows: Hampton, last in spring March 24, first in fall November 13; Norfolk, last in spring March 30, first in fall November 13; Spottsville, last in spring April 14, first in fall October 21.

PHYSIOGRAPHY AND GEOLOGY.

The Yorktown area lies wholly within the Atlantic Coastal Plain, and is separated by the York River into two parts, Gloucester County lying to the north, and what is locally known as the "Peninsula," consisting of the other four counties, to the south. The total area has a length of about 43 miles in a northwesterly-southeasterly direction, and a breadth from Jamestown Island in James River across to the Piankatank River in Gloucester County of about 28 miles. The "Peninsula" is a long, narrow neck of land extending in a southeasterly direction between the York and James rivers, with Hampton Roads and part of the Chesapeake Bay as its southern and eastern boundaries. This part of the area has the shape of a dumb-bell, being larger at both ends than in the middle. Its length is about 44 miles, reaching from Old Point Comfort to Diascund Bridge, with a width varying from 6 to about 15 miles. It is narrowest on a line drawn between Oriana and Williamsburg.

The coast line along York River is very regular, consisting of perpendicular bluffs with an elevation decreasing from 90 feet near

Ware Creek to tide level in the marsh at Toos Point, only broken by the entrance of tributary streams, while to the south of the above point to Northend Point the coast line is much broken by many large tide-water indentations, chief of which are the Poquosin River and its tributaries, and Back River and its two prongs. The beach line from Northend Point to Old Point Comfort is distinct and regular. The elevations increase toward Newport News and well pronounced bluffs of low elevation extend up to the mouth of Warwick River. Here the country for a short distance along Mulberry Island is very low, being bordered with marsh and meadow lands. At the head of this island is a roughly circular break in the neck, giving this part of the area its dumb-bell shape, while to the north are the more broken shorelines of the flats of the James and Chickahominy rivers. The "Peninsula" is inclined toward the southeast. The surface features of the lowest terraces are low and flat. These terraces are bordered by large areas of marine marsh. The inland areas ascend slightly toward the northwest, with a varying altitude of from 4 to 30 feet.

From Leehall the country rises toward the northwest, until an altitude of about 125 feet is attained. The upland surfaces are composed of slightly rolling to dissected hills, the latter bordering the stream courses. In the southern part of the "Peninsula" the elevation above sea level is so slight that in places adequate drainage can not be secured, and as a result many large inland swamps occur.

The drainage of this part of the area is east, west, or south to the York and James rivers, and Hampton Roads, respectively. The tidal streams do not usually extend very far inland, although the heads of many of them reach the fall line. At their mouths they are frequently as large as rivers, but they decrease rapidly in size as they recede from the zone of tidal influence.

The northern part of the area, consisting of Gloucester County, is elongated in a general northwesterly-southeasterly direction between Mobjack Bay and York River, and is irregular in shape, being narrowest at the southeastern extremity. It has a length of 24 miles from Gloucester Point to Dragon Bridge and a width east and west that varies from 7 to 14 miles. The general inclination and drainage is southeasterly, or seaward, with the lateral drainage northeast into the Piankatank River, east into Mobjack Bay, and south and west into York River. The Piankatank River and Dragon Creek, forming the northern boundary of the area, flow in a southeasterly direction. Above Burkes Ferry the Piankatank narrows rapidly and becomes a meandering stream, along which is developed considerable marsh. The adjacent bottoms in places are well-defined terraces of low altitude, which abut upon the bluffs of the uplands. From Burkes Ferry eastward the river widens rapidly and is marked by bluffs that range from 20 to 60 feet in elevation. These are frequently dissected by tributary streams, the transported material of which has been deposited as bottoms and sand bars.

Gloucester County is separated into two physiographic divisions marked by a distinct escarpment varying from 20 to 60 feet in height and extending in a north-northeasterly direction from Gloucester Point to the Mathews County line, or the northwest head of North River. This bluff is not continuous, having been lowered and broken in places by the eastern drainage system.

The forelands east of this escarpment are irregular in outline, forming many narrow necks and miniature peninsulas, and the North, Ware, and Severn rivers and their tributaries have large and deep tidal indentations. The forelands are characterized by broad, level necks, with an elevation that rarely exceeds 20 feet above mean tide, and which decreases slowly as Mobjack Bay is approached. The more southerly necks are fringed with marine marsh and mud flats. The fall in general is so slight that adequate natural drainage does not exist, and the result is that the more inland areas are characterized by swamps or wet woodlands.

The shore line of the York River is not so irregular as that of Mobjack Bay, probably on account of the swift currents in the former. This shore line is generally characterized by vertical bluffs which in the vicinity of Gloucester Point range from 20 to 60 feet, gradually decreasing in elevation to the eastward. The western shore is notched and lowered in places by the York River tributaries and bordered in places by marine marshes and mud flats.

The uplands of Gloucester County have a range in elevation of from 30 to 120 feet above sea level, the greatest height being attained in the northwestern part, in the vicinity and to the westward of Ebenezer Church. The surface is gently rolling or rolling, while the stream courses have generally notched through the unconsolidated materials, and are marked by roughly dissected hillsides.

The materials that go to make up the surface deposits of the area surveyed are known geologically as the Columbia formation, and have a thickness of from 10 to 30 feet. They consist of unconsolidated fine sands and sandy clays in alternating layers, together with occasional deposits of fine gravel. They have been derived from the eastern Appalachian region, and transported and deposited by streams in shallow estuaries and deltas during the building of the great Atlantic coastal flood plain. The weathering of these deposits has resulted in the formation of the soils of the area.

SOILS.

The classifications of the various soil types were based largely upon texture, physical properties, and position with respect to drainage.

The more doubtful areas along contacts were thrown with the types which they more nearly approximated in agricultural value.

The soils range in texture from clay and silt to fine gravel, although the predominating types consist of fine to medium sandy loams.

The following table gives the names of these several soils and their extent in the present survey. Many of them have a wide distribution throughout the Atlantic coastal region, as indicated by surveys already completed:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Norfolk fine sandy loam	144,064	37.6	Portsmouth sandy loam	20,032	5.2
Norfolk sandy loam	94,016	24.5	Norfolk coarse sandy loam	4,288	1.1
Leonardtown loam	36,800	9.6	Portsmouth clay loam	2,176	.6
Portsmouth fine sandy loam	29,760	7.8	Galveston sand	1,984	.5
Swamp	26,368	6.9	Norfolk clay loam	1,856	.5
Galveston clay	21,568	5.7	Total	382,912	

PORTSMOUTH FINE SANDY LOAM.

The soil of the Portsmouth fine sandy loam consists of a light, friable sandy loam, of a generally fine texture, and from 8 to 24 inches deep, containing a few particles of coarse white quartz sand, while over the surface and throughout the profile there is in some localities a scattering of well-rounded gravel rarely exceeding one-half inch in diameter. Light to dark gray is the usual color of the surface soil when dry, but when wet it assumes blackish or brownish shades. The subsoil consists of a plastic sandy loam or sandy clay, sometimes of a rather impervious nature, to the depth of 3 feet, where it is generally underlain by coarse wet sand. The color of the subsoil is gray or drab, mottled with blues and browns.

A phase of this type occurs in some of the areas of poorest drainage. The soil is here generally slightly darker in color, rather heavier in structure, and finer in texture than in the main body of the type. The depth of the top soil is usually also somewhat more shallow. These areas generally grade almost imperceptibly into the lighter, looser surrounding soil of the Portsmouth fine sandy loam. Areas of this heavy phase are to be seen northeast of Gloucester Point, northeast of Phoebus, along the main road from Hampton to Newport News, and in a few other localities in Elizabeth City County.

The distribution of this type is confined to the lower or eastern portion of the area, or east of a line drawn south from Wormleys Creek to Newport News in the "Peninsula," and on the forelands east of the escarpment, in Gloucester County. It is well developed in a large unbroken area in the peninsula known as Guinea Neck, lying south of Severn River, though it is noticed to be less typical nearest the escarpment and nearest the mud flats of Mobjack Bay. A good development of it is also seen north and northeast of Grafton, southeast of Poquoson, and north and northeast of Newport News, but it is less typical south of the southwest prong of Back River and in isolated patches south and east of Harrison Creek.

This type occupies level or depressed interstream areas, with an altitude that rarely exceeds 20 feet above mean tide, while in some places it is scarcely above high-water mark. In Gloucester County the lowest areas have an elevation of about 3 feet above mean tide. With few exceptions the Portsmouth fine sandy loam occurs in areas more or less remote from tidal streams. The fall is so slight that the greatest difficulty is experienced in getting adequate drainage, and as a consequence but a small proportion of the type is under cultivation. In fact, a great part of the area occupied by this character of soil material is covered with forest. During early spring it is wet or in a swampy condition. The worst of such areas have been mapped as Swamp, since there is little chance of improvement under present conditions.

A suggestion in this connection might not be amiss. It would seem possible to direct the waters of the swampy heads of the southwest prong of Back River to Salters Creek and drain the neighboring country by the extension of laterals to the main by surface ditching to the underlying sand. The surface water could then be carried off and drainage established. This would open up valuable tracts of land now unfit for agricultural purposes.

The original timber growth of this type is not known, but the forest areas now consist of old field pine, sweet and black gum, and oak. This type owes its origin to the reworking of the finer estuarine deposits with the sand bars developed by river currents.

The cultivated areas are used for the production of potatoes, corn, and grass, with such secondary crops as cabbage, lettuce, and root crops, or strawberries and small fruit. The character of the truck crops depends largely on condition with respect to drainage. The grasses are relatively unimportant on this soil. Little timothy is grown; orchard grass and red top are more in favor.

The following are the reported crop yields of this soil type: Irish potatoes, from 50 to 150 bushels to the acre, and sweet potatoes, an average of 200 bushels. The yield of corn is very low, only 10 to 20 bushels to the acre. Hay (red top and clover) yields 1 ton to the acre, while orchard grass returns 2½ tons in three cuttings. The fields are often cultivated in ridges to protect the crops from the accumulation of water after showers. Fertilizer is secured by turning under pasture sod and by the use of a small fish called "alewife" or "bunker."

These lands are valued at from $12 to $75 an acre, depending on improvements and location with respect to markets.

The following table gives the average results of mechanical analyses of the fine earth of samples of the soil and subsoil of this type:

Mechanical analyses of Portsmouth fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11376, 11379, 11383, 12262, 12264.	Soil	0.4	3.1	6.5	47.9	7.8	21.1	13.5
11377, 11380, 11382, 12263.	Subsoil	.2	2.2	4.2	32.8	9.2	27.4	21.5

NORFOLK CLAY LOAM.

The Norfolk clay loam consists of a chocolate-brown clay loam with a depth of about 6 inches, passing rapidly into a very dense, massive, waxy clay of a dark reddish-brown color. At about 24 inches it contains a small amount of very fine sand, while the color becomes somewhat mottled. In a few of the examinations of this type, at depths exceeding 3 feet, it was underlain by thin layers of shell marl. When in a normal moisture condition the surface of the soil possesses a fair tilth, but when wet it is very plastic and sticky, so much so that it balls in front of the plow and makes uneven furrows.

The Norfolk clay loam has a very limited distribution, occurring in a large unbroken area to the north of Shell Banks (normal school farm) and west of Brooks Point, and in a much smaller one 3 miles farther west. The surface has a flat or depressed appearance and lies at an elevation of about 10 feet above sea level.

The natural drainage is fairly well developed, although the fall is so slight that much of these areas is imperfectly drained, particularly in the wooded areas, where the water remains for long periods after rains.

The Norfolk clay loam is an estuarine deposit laid down in more recent Pleistocene time and subsequently elevated.

On this type the forest growth is made up largely of hardwood and old field pine. The cultivated areas are used largely for the production of hay and corn, but the greater part of the type is used as pasture. Corn has an average yield of about 30 bushels to the acre, although 60 bushels have been grown under good conditions. Timothy and clover hay yield from 2 to 3 tons to the acre, while the pastures are almost permanent.

Prior to the sixties this type was one of the most important wheat soils of the Peninsula. It is said then to have produced from 30 to

50 bushels to the acre, while now it rarely produces 10 bushels to the acre, and the cultivation of this crop has been practically abandoned.

The Norfolk clay loam, under good cultural methods, should be a very productive type for grass and grain.

The following table gives the results of mechanical analyses of this soil type:

Mechanical analyses of Norfolk clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11399	Soil	1.0	3.2	7.6	22.6	7.1	34.8	23.9
11400	Subsoil	.5	3.6	6.1	17.8	6.9	32.2	32.9

PORTSMOUTH CLAY LOAM.

The Portsmouth clay loam is locally known as the "black lands." It consists of a clay loam to about 6 inches deep, which grades abruptly into a very dense, massive, and waxy clay which at 24 inches contains a small amount of very fine sand. The local name of the type gives some idea of the color of the surface, which varies from ashy gray to brownish black. The immediate subsoil is usually a brownish black to about 24 inches, when it changes to mottled grayish blue. Marl sometimes occurs below 3 feet. Upon drying out the surface breaks up into cracks; where further shrinkage continues the soil breaks up in crumbs, which gives it a porous structure, but when wet it is very plastic and sticky, so much so that it is worked with the greatest difficulty and fails to scour from the plow.

The Portsmouth clay loam occurs in isolated areas throughout the forelands in Gloucester County, to which it is confined almost exclusively, and where it is partially or wholly surrounded by Portsmouth sandy loam.

The Portsmouth clay loam has an elevation of from 10 to 20 feet above mean tide and occupies flat or troughlike depressions. The greatest difficulty is experienced in securing adequate drainage, as there is but little fall to the neighboring watercourses. More generous surface ditching or tiling would do much to alleviate the poor drainage conditions of this type. Many of the present ditches were observed to be obstructed by an accumulation of trash and litter.

The type is an estuarine deposit. The same character of material is being formed at the present time in the shallow indentations, where the sluggish rise and fall of tide develops but little current.

The Portsmouth clay loam is used for the production of corn, wheat, and grass. The yields of corn range from 10 to 40 bushels; wheat, from 7 to 20; hay (mixed), from 1 to 2½ tons to the acre, while the pastures last from 4 to 6 years. The Portsmouth clay loam is a strong productive type for grass and grain when well drained. The cultivation of this type is generally too shallow, rarely exceeding a depth of 4 inches.

The Portsmouth clay loam is valued at prices that range from $15 to $40 an acre.

The following table gives the average results of mechanical analyses of samples of this type of soil:

Mechanical analyses of Portsmouth clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12278, 12280	Soil	0.1	1.3	4.5	26.5	7.7	38.4	21.3
12279, 12281	Subsoil	.2	1.9	4.9	28.7	4.8	38.2	21.0

PORTSMOUTH SANDY LOAM.

The Portsmouth sandy loam, locally known as the "gray land," consists of a fine to medium sandy loam of grayish-brown color, ranging in depth from 6 to 14 inches. This material passes rather abruptly into a heavy, massive, sandy clay of a mottled brown color, changing at a depth of 24 inches into a less sandy clay mottled with steel blue and gray and very similar in color and texture to the deeply lying substratum of the Norfolk clay loam.

The Portsmouth sandy loam occurs along the forelands in the eastern part of the area, with its best development east of the escarpment in Gloucester County. Here it wholly or in part surrounds the more local development of Portsmouth clay loam and swamp, occasionally abutting on tidewater, but more often bordered by the Norfolk sandy loam. The type occupies the major portion of Sadlers, Wares, and Robbins necks in Gloucester County, while south of the York River the largest areas typically developed border Queen Creek, northwest of Green Springs; several areas are also found in the vicinity of Poquosin River and the Northwest Branch of Back River.

The Portsmouth sandy loam has an altitude that ranges from 4 to 20 feet above sea level. The surface of the type is flat to gently rolling, sloping slightly toward the southeast. The type is fairly well drained as it nears the watercourses, but imperfectly so as it extends farther back where the fall is insufficient.

To obviate poor natural drainage most of the corn lands are thrown up in ridges with deep intervening furrows. Trenches are located at convenient intervals to catch what water accumulates on the surface.

The distribution of this soil seems to be governed by the local reworking of fine sand with deposits of clay in the shallow water of estuaries. The topography of the type varies generally from level to slightly rolling. Very little of it supports the original growth of hardwood, although much of it is covered with a heavy growth of old field or loblolly pine which has taken possession of the fields since the war.

The Portsmouth sandy loam is used for the production of corn, wheat, and grass, supplemented by potatoes, peas, and such general truck and orchard products as are needed for home consumption. The following are the reported yields from areas representing the general productiveness of the type: Corn, 10 to 20 bushels; wheat, 7 to 15 bushels, and hay from 1 to 1½ tons to the acre. Yields greatly in excess of the above for corn and wheat were reported from fields in better condition, where the former was reported as high as 40 bushels and the latter 20 bushels to the acre. This type is easily worked and responds readily to good treatment.

The methods of crop rotation in use vary considerably. Corn may be planted for from one to three or four seasons on the same field, followed by wheat, in which timothy and clover are sown. After the grass has been cut for hay for one or two years the fields are used as pastures for indefinite periods. A common practice is to follow English peas and potatoes with corn, repeating each season. Sometimes cowpeas are sown with the corn at the time of last cultivation. To improve fields of this type the pasture sod is turned under, or such green manuring crops as cowpeas or German clover, on which is sown acid phosphate. Small fish known as alewives are sometimes used for corn.

In general this type is in very poor condition, natural drainage is frequently inadequate to carry off surface water, and were it not for the practice of ridge cultivation the crops of corn and potatoes would be much lower than they are at present.

The Portsmouth sandy loam is valued at from $15 to $150 an acre. Many wealthy people have built summer homes on the rivers and own large areas of this type.

The following table gives the average results of mechanical analyses of the fine earth of typical samples of this soil:

Mechanical analyses of Portsmouth sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11393, 11395, 12274, 12276.	Soil	0.9	5.9	14.4	39.2	16.8	14.6	7.9
11394, 11396, 12275, 12277.	Subsoil	.5	5.1	12.0	38.4	4.7	16.9	22.1

LEONARDTOWN LOAM.

The Leonardtown loam consists of an ashy-gray, yellowish-brown, or brown silty loam, 6 or 8 inches deep, grading into a silty clay of somewhat lighter color, which in turn is underlain to a depth usually exceeding 3 feet by a yellow or grayish silty clay in which a small amount of fine sand is sometimes present.

The Leonardtown loam occurs in large, irregular areas. A long, narrow area extends from Leehall nearly to Newport News, in Warwick County, while others are situated along the James and Chickahominy rivers, in James City County. In Gloucester County a large broken area extends for a distance of about 9 miles northwest from Whitemarsh, while another area of nearly 15 square miles extent, known as the "barrens," occurs in the northeastern part of the county, near the Mathews County line.

The surface is usually characterized by swampy depressions and kettle holes, in many of which standing water is found throughout the year. This type ranges in elevation from about 20 to 120 feet above sea level, but natural drainage is far from established and the greater part of it is in its present condition unfit for agriculture.

The greater part of the Leonardtown loam is covered with forest growth, although the original white oak timber has largely disappeared. The growth at present consists largely of loblolly or old field pine and scrub oak, with sweet gum in the poorly drained depressions.

The Leonardtown loam is one of the most important of the upland types and some of it is under a high state of cultivation. On the other hand, portions of it have reached the lowest degree of productiveness.

The cultivated areas are used for the production of corn, wheat, grass, and potatoes. Wheat and potatoes are, however, of secondary importance.

The following are the reported yields: Corn ranges from 10 to 50 bushels; wheat, from 7 to 20 bushels; hay, from 1 to 1½ tons; potatoes, from 50 to 100 bushels to the acre.

A common treatment to improve the fields of this type is to use German clover or field peas as a green manure, on which is sown acid phosphate. The Leonardtown loam readily responds to this treatment. The cultivation of the type is generally shallow, although ridged for corn. The compact nature of the surface soil, together with the fine texture, does not permit of ready percolation of accumulating water, and the crops are generally late in starting and long in maturing as compared with lighter types.

The Leonardtown loam is well adapted to dairy farming or to stock raising. All the forage crops do well and the pastures are said to be almost permanent.

The following table gives the average results of mechanical analyses of typical samples of this type of soil:

Mechanical analyses of Leonardtown loam.

Number.	Description.	Fine. gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11363, 11365, 12254, 12256.	Soil	0.7	3.9	4.5	21.9	14.7	42.2	13.7
11364, 11366, 12255, 12257.	Subsoil	.9	2.2	3.2	17.3	9.4	36.3	29.1

NORFOLK COARSE SANDY LOAM.

The Norfolk coarse sandy loam consists of gray or brown sandy loam, of a medium to coarse texture, containing some very fine gravel. The surface 6 inches is usually underlain by a less loamy sand of the same coarse texture, which at 24 inches becomes a coarse sandy or fine gravelly clay. This stratum rarely exceeds a thickness of 2 feet, and it more often occurs as a thin layer from 6 to 12 inches in thickness, and is in turn underlain by fine gravel and coarse sand. The surface soil has a peculiar porous structure and is slightly sticky from the presence of clay and silt, which envelops the sand and gravel particles. The darker color of the surface soil gives way to red and yellow as the depth increases. The subsoil proper (sandy or fine gravelly clay) has a structure similar to the surface, but with the interstices not nearly so pronounced.

The Norfolk coarse sandy loam, which occupies a relatively small area, occurs in one important tract on the river forelands northwest of Yorktown and in another extending almost due south of Wormleys Creek in a long, narrow strip to within one-half mile of the Poquosin River. Other narrow bands of irregular outline and small isolated patches occur in the Swamp areas throughout the southern part of the "Peninsula." It does not occur in Gloucester County.

This type occupies level to ridgelike topography. It probably owes its origin to the formation of bars or ancient beach lines or to deposition in rapid currents during the building up of flood plains.

The Norfolk coarse sandy loam generally needs underdrainage, particularly in the vicinity of the Swamp areas, where borings in many instances showed water at a depth of 3 feet or less. This nearness of the ground water to the surface restricts the adaptation of the land so affected, and corn and grass are produced to the general exclusion of other crops. The greater proportion of such areas, however, is occupied by woodland, approaching in condition the Swamp type. The tops of the ridges, or that part of the type with a low water table, is used for the production of early truck.

Corn yields from 10 to 20 bushels and hay about 1 ton to the acre. A wide variety of truck crops is grown. Used for this purpose the type is very valuable, as the crops mature about two weeks earlier than on any other soil, and the advantage of the highest market prices is secured.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Norfolk coarse sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11370, 11372	Soil	16.4	27.9	8.9	12.2	2.5	18.7	13.0
11371, 11373	Subsoil	16.3	30.0	8.2	7.9	1.9	19.8	15.1

NORFOLK SANDY LOAM.

The Norfolk sandy loam, to a depth of about 8 inches, consists of a fine to medium sandy loam of a gray or yellowish-gray color. This material grades into a less loamy orange or yellow sand which retains the same general texture to depths varying between 8 and 24 inches, where it rests upon an orange or yellow sandy clay. The sandy clay of the subsoil proper is generally of a light character and frequently has a depth of not more than 12 inches, underneath which incoherent sand occurs. Where it attains a greater thickness it usually becomes much more massive as the depth increases. Nearest the tide-water streams along the edge of the escarpment in Gloucester County and in other positions where drainage and topography are favorable to the formation of a deep soil, the Norfolk sandy loam in many instances possesses the characteristics and agricultural value of Norfolk sand.

With the exception of the Norfolk fine sandy loam this type has the largest distribution of any in the area. It occurs in many parts of the "Peninsula," more particularly in the neighborhood of Hampton and to the south of Newport News. It is also found to the north of Leehall, extending from the James River across to the York River. Large areas of it are developed to the north of Toano and in the vicinity of Ewell and Lightfoot. In Gloucester County large areas are found throughout the length of the county immediately north of York River and also in narrower bands skirting the Piankatank, North, Ware, and Severn rivers. In its distribution it is neither confined to the uplands nor lowlands, although larger areas of it occur in the former than in the latter position.

The surface of the Norfolk sandy loam where it occurs in broad areas is usually level to gently rolling, although it is steep and hilly along stream slopes. The type is derived from materials belonging to the Columbia formation of Pleistocene age and was deposited in marine waters during the building of the Coastal Plain.

Probably more of this type than any other is under cultivation, although much of it is at present unimproved. The timber growth consists almost altogether of old field pine and scrub oak. The Norfolk sandy loam is naturally the best drained soil in the area. It is used for light farming, particularly for the production of corn, potatoes, and truck crops. The following yields are reported: Corn from 10 to 30 bushels, with somewhat greater yields under the most favorable conditions; potatoes from 75 to 140 bushels; sweet potatoes, though not grown extensively, from 100 to 200 bushels; peas from 50 to 70 bushels, and peanuts, on a small acreage, from 50 to 100 bushels to the acre. Alfalfa has been successfully grown upon this type, though the acreage devoted to it is very limited. Yields of from 3 to 5 tons are reported for five cuttings.

Melons and early potatoes are the principal truck crops. Improved farms of Norfolk sandy loam favorably situated with reference to railroad and steamboat transportation lines range in price from $50 to $80 per acre.

The following table gives the average results of mechanical analyses of samples of this soil:

Mechanical analyses of Norfolk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11387, 11389, 12268, 12270.	Soil	0.4	9.4	13.8	46.8	10.3	11.3	7.6
11388, 11390, 12269, 12271.	Subsoil	.9	10.0	13.1	38.6	11.1	12.6	13.6

NORFOLK FINE SANDY LOAM.

The Norfolk fine sandy loam consists of a fine sandy loam of a gray or brown color, with a depth of about 10 inches, at which depth it usually grades into a more compact material of the same texture. This is underlain at depths varying from 12 to 24 inches by a reddish-yellow sandy clay, while at depths usually exceeding 3 feet the underlying material generally consists of alternating strata of clay and sand. The color of the subsoil is varied, although different shades of red and yellow predominate.

The Norfolk fine sandy loam, which is the most extensive type in the area, is found in broad bodies on the upland in all parts of the area surveyed west of a line drawn about north from Newport News. It occupies a level to rolling country, usually more rough and broken as it approaches the water courses, where a difference of from 20 to

60 feet in the elevation is not infrequent, making the slopes very steep. The Norfolk fine sandy loam is generally well drained, but occasional spots occur where the conditions are similar to those found in the Leonardtown loam.

Although this type covers the largest area of any type in the survey, probably less than 50 per cent of it is under cultivation. The remainder has a growth of small timber, loblolly pine and oak predominating. A great part of this growth has spread over the fields since the civil war.

The cultivated areas are used for a variety of crops, depending upon the depth of surface soil and the location with respect to market. In the areas more remote from the railroad or towns the production of corn and grass are the chief interests, supplemented by potatoes and such other truck crops as are needed for home use. Where, however, the surface soil is deeper (reference being made more particularly to the areas in the vicinity of Toano and to the north), a specialization is made in the production of early potatoes, melons, tomatoes, and cucumbers. In the areas more remote from markets yields of corn and potatoes are relatively low as compared with yields in the areas of deep soil, and the greater proportion of the acreage is used for grass and small grain, the yields of which are relatively large. The general system of cropping is to plant corn successively for three or four years and then to use the fields for pasture for indefinite periods. The pasturage consists of native grasses which come up voluntarily. A growing custom, however, is to follow corn with wheat in which timothy and clover are sown. Hay is then cut for two years, after which the fields are used for pasture. The productiveness of the field is maintained by turning under the pasture sod, crimson clover, and peas as green manure.

The following yields are reported for Norfolk fine sandy loam: Wheat, 7 to 20 bushels; oats, 20 to 30 bushels; corn, 10 to 35 bushels; potatoes, 50 to 200 bushels; hay, from 1 to 2 tons, and cucumbers from 2 to 3 tons to the acre. Apples, pears, and small fruits are also successfully grown. This type of soil is valued for agricultural purposes at from $10 to $100 an acre.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Norfolk fine sandy loam:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11357, 11359, 12248, 12250.	Soil	2.2	4.8	9.9	39.6	10.2	25.5	9.3
11358, 11360, 12249, 12251.	Subsoil	3.2	4.3	8.6	33.9	8.0	24.0	20.5

GALVESTON SAND.

The Galveston sand is a fine to medium brown, yellow, or grayish-yellow sand with a depth of 3 feet or more. In some areas in Gloucester County there is an abrupt change in color at about 10 inches. Over the surface and throughout the soil in some of the areas mapped in Elizabeth City County there is a scattering of large, rounded black gravel, usually from 4 to 6 inches in diameter. This type occupies narrow strips of shore line along Hampton Roads, north of Old Point Comfort, and along York, Severn, and Ware rivers, the areas varying in width from one-sixteenth to one-fourth of a mile.

The Galveston sand usually occurs in hammocky or ridgelike bars sloping seaward. As the distance increases from the shore line the surface becomes gently rolling.

The material composing this type is a beach sand so incoherent when dry as to be readily moved from place to place by the force of the wind. The surface depressions are usually somewhat swampy, while the knolls are usually characterized by the growth of pine, scrub oak, laurel, and cacti.

Where covered with vegetation the surface soil is usually of a darker color from the presence of decomposed organic matter. Only a small proportion of the type is fitted for agricultural purposes.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Galveston sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11369, 12260	Soil	0.8	19.8	21.8	49.9	1.7	3.4	2.5
12261	Subsoil	1.6	22.8	26.7	36.0	2.4	6.6	3.7

GALVESTON CLAY.

The Galveston clay consists of lowlands bordering nearly all the large and some of the smaller tidal streams. These are covered with water at high tide, and the vegetation is characterized by salt grasses of different varieties. The largest and most extensive areas are developed to the east and north of Messick on the Chesapeake Bay and Back River, and along York, James, and Chickahominy rivers. As the elevation increases the Galveston clay usually gives way to swamp. The areas of Galveston clay are of no agricultural value and could only be reclaimed by diking and pumping the water out.

SWAMP.

The Swamp mapped in this area consists for the most part of irregular inland areas of woodland and narrow wooded areas skirting the smaller streams, above the influence of salt-water tides. Many of these interior areas of woodland swamp, which occur mainly between Oriana and the arms of Back River, and upon the lowland portion of the escarpment in Gloucester County, are susceptible of drainage, and when reclaimed will probably develop a type of soil quite similar to that of the Portsmouth fine sandy loam, valuable for the production of the heavier truck crops and for general agriculture. At the present time these areas are covered principally with loblolly pine, sweet gum, and willow oak.

AGRICULTURAL METHODS.

The area surveyed lies in what is commonly known as the "corn belt" of Virginia. Corn is the chief product, but is not grown to the general exclusion of other crops, being supplemented generally by grass and truck crops.

The cultural methods are quite variable and depend largely on the character and condition of the soil. On some of the soil types, either as a result of the fineness of the texture or close structure, and on portions of the types poorly drained, the crops are so late in starting and slow in maturing that but one crop can be grown in a season. Among the types wholly or partly in this class are the Leonardtown loam, Portsmouth fine sandy loam, Norfolk clay loam, and Portsmouth sandy loam.

On the lighter types of soil or on those whose texture is coarse—with consequent more open structure—or on portions of the types already mentioned where drainage conditions are good, two or more crops are secured from the same field in a single season. Among such soils may be classed the Norfolk coarse sandy loam, Norfolk sandy loam, Norfolk fine sandy loam, portions of Portsmouth fine sandy loam, and Portsmouth sandy loam.

The customary practice on soils in the first group is to plant corn year after year until the soil has reached the minimum yield acceptable to the producer, when it is followed by grass which may or may not include clover, and the field used as pasture for indefinite periods or until the lands have recuperated sufficiently again to produce a profitable crop. Where corn follows corn, as above, a growing custom is to sow cowpeas or Canadian peas between the rows or every alternate row.

On the lighter types, particularly on the early truck soils—the Norfolk sandy loam, Norfolk coarse sandy loam, and the better-drained areas of Portsmouth fine sandy loam—the general practice is to grow, season after season, garden peas and Irish potatoes, followed by corn the same year. The peas and potatoes are sown in alternate rows about 4 feet apart, and the corn is planted in furrows developed by plowing to remove the pea vines. Occasionally a field of potatoes is followed by corn, but in general corn does not have time to mature after potatoes, although the Norfolk sandy loam and portions of the Norfolk fine sandy loam along the shore of the Chesapeake Bay are early enough to permit this rotation.

Where the types last named occur in the vicinity of Hampton, Newport News, and Toano they are used almost entirely for the production of early truck. Some fields of this soil are used year after year for the production of Irish potatoes—either two crops, early and late, being produced, or the early crop being followed the same year by corn.

In the York River section of Gloucester County, where the trucking industry is carried on in the Norfolk sandy loam and the Norfolk fine sandy loam, the principal crops are potatoes and melons. The method of culture with melons is to plant them in hills 8 or 9 feet apart and to stir the soil with a cultivator and hand hoe until they begin vining, after which cultivation ceases and they are left to mature. They are graded according to the picking, the first bringing the highest prices. Melons are seldom grown on the same field twice in succession, and then only on a very small scale for home use. The hills in this case are usually located in the space between the old hills. Where grown commercially they are seldom grown on the same land at intervals of less than three years, and more often of four or five years. The longer the interval between the better the result, as the land is said to be " melon sick " after a crop has been removed. Melons are usually followed by corn, rye, or oats, or by such leguminous forage crops as Canadian field peas or cowpeas. Wheat is grown to some extent upon the heavier types of soil, such as the Portsmouth clay loam, Portsmouth fine sandy loam, and Norfolk fine sandy loam.

In harvesting the corn crop the custom in vogue is to pull the blades and cut off the tops of the stalk above the ear while it is still green. After the ears have ripened they are snapped off and hauled to the barn or corncrib. When the field is to be prepared for another crop, the stalks are cut down with a hoe. The corn matures much better by this method than if the entire stalk were cut and shocked, but the labor is about twice as great as by the latter method.

The cultivation of most crops is generally shallow. On account of the inadequate natural drainage of a considerable portion of the country it is necessary to practice the ridged system of cultivation, especially with corn. Following the last plowing this leaves high ridges with deep intervening furrows. This practice is very necessary in the low forelands, though it is carried to unnecessary extremes in the higher uplands, where the drainage system is fairly well developed.

Fertilizer practice varies almost with the individual. A common practice on the heavier soils, as already noted, is to sow cowpeas or Canadian peas with the corn. These are esteemed of great value in maintaining productiveness of the soil. The turning under of the pasture sod is held to be sufficient for the production of three or four crops of corn. Besides these practices some commercial fertilizer is used. The general plan in all inland areas is to use broomsedge or pine straw for bedding in stables and to incorporate it in the soil in spring or fall. Manure of this character is eagerly sought for. The pine straw is generally utilized in the fall and winter and hauled out in the spring, while the broom sedge, owing to its woody texture, requires much longer time to decompose, and is used in the stable during the summer, hauled to the field during the fall, and allowed to decompose in bulk during the winter. In parts of the area lying along the tide-water inlets a common practice is to fertilize with fish scrap or with small fish, commonly known as alewives or bunkers. This method of fertilization is used on fields prepared for corn.

The commercial fertilizers used are a 7 per cent and a 10 per cent on the basis of potash. The 7 per cent mixture is used for corn and the 10 per cent for truck. Of the green-manuring crops, crimson clover and cowpeas are most frequently used, and the practice of applying acid phosphate to help decompose the organic matter of these crops is not infrequent.

AGRICULTURAL CONDITIONS.

The chief interests of the area are its fisheries and its agriculture. The oyster fisheries of the Chesapeake Bay and tributary embayments are among the most valuable in the world, yielding annually millions of bushels of the finest quality of shellfish and giving employment to thousands. While all kinds of fish common to the middle latitudes abound in these waters, the waters that surround the east, south, and west of the area are not all natural oyster grounds. The oyster rock occurs in small areas in the more shallow waters and is developed for miles up the James River. The area along the shore line for several miles up that stream and extending out a distance of half a mile is controlled by the owners of abutting lands and is used largely for planting oysters. While the fishing and oyster interests are important occupations, they are generally followed in conjunction with agriculture, the oystering industry usually being carried on between the months of September and April.

Various degrees of prosperity exist in different parts of the area, although in general the conditions may be described as backward, and the area is still suffering to some extent from the effects of the civil war. Of the 382,912 acres surveyed, the census report of 1900 gives the number of acres in farms as 256,011, and only 109,316 acres, or about 42 per cent of the farm lands, as improved. The average size of all farms is given as 66 acres. A considerable part of the area is covered with a forest growth consisting mainly of loblolly and shortleaf pine and scrub oak and other hardwoods.

The most prosperous sections of the area, to judge from the character of the farm buildings and general improvements, are found in the tide-water trucking districts, especially in the vicinity of Hampton and Newport News, along some of the rivers connecting with Mobjack Bay, and on some of the forelands along York and James rivers. Appearances of relative prosperity are also marked in the inland areas in the vicinity of Williamsburg, Toano, and Gloucester.

The greatest diversity exists in the character of farm buildings, which vary from the old colonial manor to structures of the most approved modern pattern. Here and there are seen log huts with mud chimneys, but generally the farmhouse is a simple two-story wooden structure. The outbuildings consist of a barn for the accommodation of the work stock and a dairy cow or two, with room for the necessary forage, other small sheds for wagons and machinery, and a corn crib.

The proportion of the farms operated by the owners, as given by the Twelfth Census, is about 72 per cent. The remainder are in the hands of cash or share tenants. The cash rent demanded has a wide range—from $1 to $6 an acre—depending upon the location with respect to markets and the productiveness of the land. However, but a small proportion of the farms are rented for cash, most owners preferring to rent on a basis of a share of the crops, a practice which naturally stimulates the tenant to exercise greater care in the management of the land. Where rented on shares, the owner receives from one-fourth to one-third of the grain and an additional rental for the use of the farm buildings. Where trucking is practiced the tenant generally leaves every third or fourth row to be gathered by the owner.

The labor question is gradually becoming more and more of a problem for the farmers of the Peninsula. Laborers usually receive 75 cents a day, or, when hired for longer period, from $10 to $15 a month. During harvest as much as $1.50 or even $2 a day is paid for hands. A reliable, efficient hand has little trouble in securing employment, and the demand is so great that much difficulty is experienced in retaining him. It is not long before such men have begun to rent or to buy small farms. To another more restless class the opportunity for work in the near-by cities is more attractive, and the result is that only the less energetic and less thrifty are left. These are usually not reliable, and as soon as the fall comes the greater number are away to the free "oyster rock," where for the first month or two they may make an occasional lucky catch bringing them from $3 to $5 a day. The last census report estimates the amount expended for labor in the counties comprised within the present survey at $112,840.

That the wage is small for the more efficient labor is generally conceded, but for the class of hands secured it is usually as much as can be paid economically, because they exact almost constant supervision. Labor even of this class is growing more and more difficult to obtain, and the result is that during harvest it is not uncommon to lose a crop, while the scarcity during spring has gradually led to the abandonment of large productive areas.

Among the important crops of the area are corn, wheat, oats, hay, potatoes, sweet potatoes, peanuts, and truck. As was noted in the preceding chapter, corn is the chief crop. According to the Twelfth Census, 581,480 bushels were produced in the area in 1899, with an average yield of 14.7 bushels to the acre. Records of the yields gathered from the farmers frequently show an average for the farm as low as 5 bushels, while 60 bushels was not uncommon on the best cultivated areas. The low yield, in general, is attributed to exhaustive cropping without rotation. The most abundant yields are secured where judicious rotation is practiced, or where an endeavor is made to maintain fertility by the turning under of such green manures as crimson clover and cowpeas and by the application of acid phosphate or other fertilizers. Large yields are also secured on the Norfolk fine sandy loam near Toano, where the corn crop follows early potatoes, which are grown with heavy applications of commercial fertilizer.

Wheat is at present a crop of minor importance, although in antebellum days, before the opening up of the western wheat fields, the area was a flourishing wheat section. The census of 1900 gives the production as 16,870 bushels and the average yield per acre as about 7.2 bushels. Since these figures were prepared the acreage has increased to some extent. The production varies with the different types of soil, ranging from 5 to 20 bushels on the Norfolk fine sandy loam, Portsmouth sandy loam, Portsmouth fine sandy loam, Portsmouth clay loam, and Norfolk clay loam, the largest yields being generally secured from the last four types.

The oat crop is much more important, although not developed as it should be. The yield for 1899 was 19,200 bushels, an average of 13 bushels to the acre. The highest yields were reported from the Norfolk fine sandy loam and the Portsmouth sandy loam. Considerable quantities of wheat, oats, and rye are cut green and used as forage.

The production of clover crops has increased considerably in the last few years. The idea that red clover can not be produced without a nurse crop is being disproved, and many fields are encountered. Crimson clover is rapidly acquiring a place as a soil renovator. The production of clover is given in the census report as 1,244 tons, and average yield per acre as 1.1 tons, while 5,578 tons is the estimated production of tame grasses other than clover, an average yield of a little over 1 ton to the acre. The grasses include timothy, redtop, orchard grass, and Bermuda grass. The production of timothy hay could be profitably increased.

The production of early potatoes for the northern markets is developing into an important industry. One buyer in 1904 spent $13,000 in the purchase of this product for shipment to Detroit. The census of 1900 gives the production of the entire area as 135,323 bushels, or an average of 79½ bushels to the acre, the highest yields being reported from the Norfolk fine sandy loam and the Norfolk sandy loam. The industry has been extended considerably since 1899, the year to which the census figures pertain. The production of sweet potatoes is about one-half that of Irish potatoes, the average yield per acre being about the same.

The peanut crop is also becoming an important one, especially in the "Peninsula," and 28,036 bushels were produced in the area in 1899, an average yield per acre of 36 bushels. The production of English peas has developed considerably in the last few years. Cucumbers for pickling is another trucking crop grown to a considerable extent. These are sold to factories at Leehall, Williamsburg, Gloucester Point, and Toana and bring about 50 cents a bushel.

The varied types of soil and the conditions of climate and drainage within the area afford opportunities for a wide range of agricultural industries. The opportunity for investment in lands and the development of special crops is inviting. As a general suggestion it would be wise for the farmers of the area, except those engaged solely in trucking, to produce more grain, grass, and straw, and to feed more live stock than they do at present.

Transportation facilities in the area are excellent. The "Peninsula" is traversed in a northwest and southeast direction by an extension of the Chesapeake and Ohio Railway, which runs from Richmond to Old Point Comfort. Good service is rendered by the Old Dominion Steamship Company, whose boats ply the James, Ware, North, and Severn rivers, and by the Chesapeake Steamship Company, which runs a boat up the York River as far as West Point, and furnishes direct transportation to Baltimore. With the exception of some of the more perishable products, the greater part of the shipments are made by water. Freight rates by water are much lower than by rail. The chief markets for the products of the area are Richmond, Baltimore, Washington, and Philadelphia.

SOIL SURVEY OF PERQUIMANS AND PASQUOTANK COUNTIES, NORTH CAROLINA.

By **J. E. LAPHAM** and **W. S. LYMAN.**

LOCATION AND BOUNDARIES OF THE AREA.

Perquimans and Pasquotank counties comprise an area of about 460 square miles, situated in the northeastern part of North Carolina, on the northern side of Albemarle Sound. The center of the area is approximately in west longitude 75° 15′ and north latitude 36° 15′. The southeastern end of Pasquotank County is about 20 miles from the Atlantic Ocean, while the northwestern end reaches to within a few miles of Virginia. From the southeast to the northwest Pasquotank County measures about 33 miles, and Perquimans County 26 miles, while from southwest to northeast the distance across the two counties is 25 miles. Pasquotank County is separated from Camden County on the northeast by Pasquotank River, and upon the northwest it is bounded by Gates County. Perquimans County is bounded upon the west and northwest by Chowan County, and upon the north by Gates County. With the exception of about 2 miles of its western end, the Perquimans-Gates line runs through the Dismal Swamp, and is unmarked. The county officials were unable to supply exact information respecting its location, and its approximate position is therefore drawn upon the map as nearly as may be from

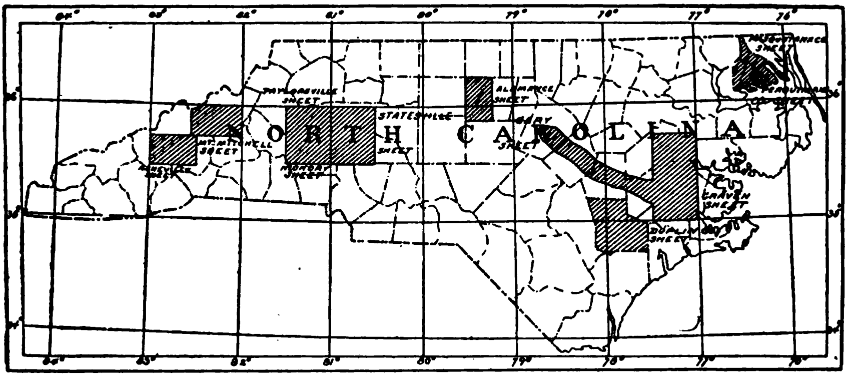

FIG. 9.—Sketch map showing location of the Perquimans and Pasquotank counties area, North Carolina.

hearsay and from measurement of a small-scale State map. The same indefiniteness exists respecting the location of the northwesterly 2 or 3 miles of the Pasquotank-Camden line, where the Pasquotank River commences its existence in the Dismal Swamp. The Pasquotank-Gates and part of the Pasquotank-Perquimans lines were mapped according to data furnished by an old sketch found in Pasquotank County court-house, the more explicit memoranda of the early survey having been destroyed.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The history of the early settlement of this area began in 1662, when George Durant purchased from the king of the Yeopim Indians the tract of land now known as Durants Neck, lying upon Albemarle Sound, between Little and Perquimans rivers, in Perquimans County. The title to this tract of land is the oldest on record in North Carolina, and Durants Neck is the site of the first permanent settlement in the State. Durant was soon followed by other settlers, among them a number of Quakers, who moved to North Carolina from the New England States in search of a place where they might live in peaceful enjoyment of religious liberty. Some of them also settled in Pasquotank County, and it was there, in 1703, that the oldest meetinghouse in the State of which they possess any record was built.

Perquimans and Pasquotank, together with other of the eastern counties, were, in the early history of the State, included in what was known as Albemarle County. This section of the State was then difficult of access from the north on account of the many swamps and morasses, and the lack of roads between it and Virginia. Commerce with the North was consequently greatly restricted until after the opening of the Dismal Swamp Canal in 1836. Prior to that time, and especially after the close of the Revolutionary war, the settlers carried on a brisk and profitable trade with the West Indies. This consisted principally of the exchange of lumber and such forest products as staves and shingles riven from the juniper and cypress, then so abundant in the great swamps, together with corn and other farm produce, for sugar, molasses, rum, and other products and fruits of the Tropics. Along Albemarle Sound fishing was then, as now, an important industry. Corn is and always has been the principal farm crop of the area, though prior to the competition of the West wheat was also grown to quite a large extent. Cotton was grown at an early day, the seeds being removed by hand and the fiber manufactured into clothing on hand looms, but it did not reach a position of importance among the products of the area until after the close of the civil war. In 1900, according to the Twelfth Census, about 5,400 bales were reported in the area.

After the construction of the Dismal Swamp Canal, up to 1881, communication with the outside world was by boat; but in the latter year the Norfolk and Southern Railroad penetrated the Albemarle section, bringing to the inhabitants readily appreciated facilities for the speedier transportation of freight, as well as an improved passenger and mail service. In the last decade the agricultural and industrial progress has been more rapid than before, and farm and real estate values are gradually advancing.

CLIMATE.

The climate of the area is characterized by long summers and comparatively short, mild winters. The average annual temperature, as shown by the appended table, prepared by the Weather Bureau, is 60° F., which is 1° warmer than at Norfolk. The distribution of the temperature and rainfall over the different months is favorable to a long growing season, and few summer days are so disagreeably hot as to interfere seriously with work out of doors. The autumns are generally warm and dry, and are sufficiently long to allow the harvesting of the cotton and corn crops before the rains of the winter set in. The most severely cold weather occurs during January and February. The ground, however, seldom remains frozen for more than a few days at a time, and the snowfall is light, being usually not more than an inch at a time, and remaining upon the ground but two or three days at most. Plowing is commenced in February, and potatoes are frequently planted by the latter part of that month.

Normal monthly and annual temperature and precipitation.

Month.	Edenton.		Kitty Hawk.		Month.	Edenton.		Kitty Hawk.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*In.*	*°F.*	*In.*		*°F.*	*In.*	*°F.*	*In.*
January	41.9	3.48	42.4	5.20	August	79.6	5.14	77.6	6.84
February	41.8	4.72	46.0	3.75	September	72.4	2.74	73.4	4.65
March	51.3	3.96	47.4	5.16	October	62.1	4.44	63.6	3.70
April	58.0	2.99	55.8	4.45	November	52.4	3.21	53.5	4.04
May	68.5	5.44	66.0	3.74	December	42.6	3.03	46.2	4.16
June	75.2	3.56	74.2	4.60	Year	60.5	47.79	60.3	56.09
July	80.2	5.08	78.0	5.80					

PHYSIOGRAPHY AND GEOLOGY.

The area included in the survey consists of an almost level plain, rising gently to the northwest from Albemarle Sound. Its minimum elevation above the sound in Pasquotank County is about 4 to 6 feet, and in Perquimans County is somewhat greater. The maximum height of about 50 feet is reached west of Belvidere, on a narrow terrace extending parallel with and along the Perquimans-Chowan county line. This terrace, which is evidently an old shore line, reaches over into Perquimans County for an average distance of about 1 mile, and extends northward about 8 miles, where it disappears into Chowan and Gates counties. Just off this terrace the general level is from 20 to 25 feet, giving a fall to the sound of about a foot to the mile. North of Perquimans and northwest of Pasquotank County the surface slopes to the Dismal Swamp, about 50 square miles of the southern prolongation of which is included in the area. This descent is made in a few feet, the swamp being but little lower than the surface of the surrounding country.

Perquimans and Pasquotank rivers have their rise in the southern edge of this swamp, their upper courses being characterized by narrow and tortuous channels, fringed for the most part by gum and cypress swamps of varying width. At about three-fifths of the distance from their source to their mouth they suddenly widen into estuarylike arms of Albemarle Sound, and from Elizabeth City to Wades Point, a distance of about 14 miles, the Pasquotank River averages 2 miles in width, while Perquimans River averages about 1¼ miles in width. Little River also forms an important arm of the sound, the estuarine extension of which is about 8 miles long and 1 mile wide. The widened lower courses of these rivers appear to have been, during comparatively recent geological times, tidal rivers or estuaries, like the Elizabeth River, at Norfolk, at the present time. Since the lunar tides were cut off from Albemarle Sound, by the recession of the ocean and the building of island barriers along the shore, no periodical tides exist, but only such fluctuations in the height of the water as are caused by the stronger and more constant winds, these being locally called tides. Though there is consequently little erosion from tidal scouring going on in these arms, their channels are being quite rapidly widened from year to year by the wave action upon the crumbling banks.

The stream system of the area is completed by tributary streamlike swamps, which serve as natural drainage ways, irregularly distributed over the two counties.

Geological classification places the area in what is known as the Columbia formation. This formation is built up from mineral materials brought down by streams from the Piedmont Plateau, lying to the westward, and deposited as sediments of various grades of fineness, at a time in geological history when the coast of North Carolina was submerged under the edge of the Atlantic Ocean. The distribution of these sediments was controlled by ever-varying current and wave action, modified to some extent by stream erosion after the emergence of the land. The texture of some of the soil types has also been modified in a measure by the incorporation of considerable amounts of organic matter, resulting from the decay of quantities of vegetation accumulated while the country was yet in a semiswamp condition.

SOILS.

Excluding Swamp, six distinct types of soil have been recognized and mapped in the area. The actual and relative extent of each type is shown in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.
Portsmouth silt loam	110,016	37.3
Swamp	57,536	19.6
Norfolk fine sandy loam	43,968	15.1
Portsmouth loam	41,536	14.3
Portsmouth fine sandy loam	25,472	8.6
Norfolk silt loam	9,344	3.2
Norfolk fine sand	6,976	1.9
Total	294,848	

NORFOLK FINE SAND.

The Norfolk fine sand consists of a loose, incoherent sandy soil, in most cases extending to a depth of 3 feet or more. In some instances, however, there is a slight tendency to coherency at 30 inches, indicating the presence of some silt and clay. The texture throughout the greater part of the section is that of a medium to fine sand, few coarse grains being present. The surface 7 or 8 inches ranges from a yellowish brown to a gray and possesses a variable amount of organic matter. Below this depth the color changes abruptly to a uniform yellow, which in most instances continues to 3 feet or more, though loose white sand was in some localities, especially on the terrace along the Chowan County line, encountered at 30 inches.

The Norfolk fine sand occurs in relatively small, irregular, isolated patches along the upper courses of Perquimans and Pasquotank rivers and the smaller streams in both counties. Its best representation, however, occurs along the northern half of the Perquimans-Chowan county boundary line, where it is found extending in a slightly interrupted strip about 8 miles long and 1 mile wide. Small bodies of Norfolk fine sand occur infrequently, scattered about as islands or ridges in some of the larger river swamps, as well as in the " desert." They are too difficult of access to make them of much agricultural value, and they were usually too small and irregular to warrant their designation on the map.

Along the Chowan County line the soil occupies a nearly flat-topped terrace, attaining a maximum elevation of about 50 feet, or from 20 to 25 feet higher than the general level of Perquimans County, half a mile eastward, off the terrace. The surface of the Norfolk fine sand here is generally slightly undulating, as is also the case in other parts of the area, where it occurs along the margins of swamps and streams. In the latter positions it lies from 3 to 10 feet above the level of the drainage.

Good natural drainage is secured over the greater part of the terrace phase of the type by reason of its somewhat rolling surface and the loose, porous character of the subsoil, which allows the ready percolation of excess rain waters. In a few small local spots of depression water stands for a short time following rains, and in some of these places organic matter has accumulated in sufficient quantity to color the soil almost black. Along the margins of the rivers and swamps the porosity of the Norfolk fine sand, together with its natural fall and nearness to drainage channels, secures for it adequate drainage in most cases without resort to artificial means.

The Norfolk fine sand is derived from the coarser sediments brought down from the Piedmont Plateau and deposited during submergence under the Atlantic Ocean or its estuaries. These sediments have since been rearranged and redistributed in the course of subsequent erosion. The terrace phase of the Norfolk fine sand, however, probably marks an old beach line, and the mineral particles have undergone comparatively little change in position or arrangement since the recession of the ocean.

The Norfolk fine sand is the highest type of trucking soil in the area, and is the most suitable soil for the production of the earliest vegetables and small fruits. It is especially adapted to early peas, asparagus, and sweet and Irish potatoes. It is also a good peanut soil. It is not very retentive of fertilizers, and is too droughty a soil for corn and cotton. The physical condition of the soil would be greatly improved by the liberal application of barnyard manure.

With the exception of a few peas and Irish potatoes little trucking is done in the area, and the type is devoted to various ordinary farm crops. Cotton and corn are grown, the former yielding about half a bale to the acre under fertilization, and the latter from 5 to 15 bushels. Sweet potatoes for home consumption are grown upon this type, and to some extent for shipment, and give fair yields. In Perquimans County a portion of the area of the type is devoted to the production of peanuts. Little fruit is grown, except on the terrace phase on the western edge of Perquimans County, where the Scuppernong and Mish grapes are cultivated both for home consumption and market.

The following table shows the results of mechanical analyses of typical samples of the Norfolk fine sand. The figures represent the averages for two samples each of soil and subsoil.

Mechanical anaylses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
12451, 12449	Soil	0.0	3.6	12.7	66.1	4.4	7.0	6.1
12452, 12450	Subsoil	.1	3.2	10.8	69.7	4.0	7.5	4.5

NORFOLK FINE SANDY LOAM.

The soil of this type is a yellowish-gray fine sandy loam extending to a depth of about 10 inches. The first 6 inches of this section is not infrequently a quite incoherent fine sand, becoming loamy before the limiting depth of the soil is reached. The subsoil to an observed depth of 36 inches is a mottled yellow and gray fine sandy loam, becoming quite heavy in the intermediate depths and containing considerable silt and clay. At from 30 to 36 inches a tendency is frequently shown toward a sandier, coarser texture. There are a few areas of local extent where the surface soil is a darker gray than usual, and where the subsoil shows rather less of the yellow iron coloring. This condition is usually found in localities contiguous to the Portsmouth fine sandy loam or Portsmouth silt loam.

The greater proportion of this type lies in the central and upper parts of the two counties, where it usually occurs in positions adjacent to streams and drainage sloughs and swamps.

Slight undulations are usually exhibited in the topography of the Norfolk fine sandy loam, and the natural drainage is somewhat better than that of the Portsmouth silt loam. Except immediately along the streams, however, ditching is necessary to fit the land for cultivation.

The Norfolk fine sandy loam is of sedimentary origin, and is the result of the same processes which operated in forming the other soils of the area. To the assorting power of water is due, in some measure at least, the absence of the type from the lower river necks and the deposition of these coarser sediments higher up the stream.

Except that the texture of this type is rather light for corn, it is one of the best soils in the area for general farm purposes. It is a very good soil for cotton, possessing a subsoil retentive of moisture and fertilizers. Cotton comes to earlier maturity than upon the heavier gray soils and gives fair yields, about three-fourths bale to the acre being a good average. Corn produces about 18 bushels per acre. It is not so well suited to peanuts as is the Norfolk fine sand.

There is a phase of the Norfolk fine sandy loam, occurring mainly along the narrow drainage swamps and also adjacent to the swamps that border the narrow parts of the Perquimans and Pasquotank rivers in the upper parts of the two counties and in the vicinity of Hertford and Elizabeth City, which differs somewhat from the general description above given, more especially as regards adaptation to crops. The soil from 10 to 18 inches is a brown, slightly loamy sand of fine texture, underlain to a depth of 36 inches by a heavier yellowish to reddish sandy loam, becoming quite compact in the lower depths. In some localities, however, especially near areas of the Norfolk fine sand, the subsoil is less compact, possessing a loose, loamy consistency throughout.

This phase of the Norfolk fine sandy loam is perhaps the best all-round trucking soil of the area, and is well adapted to the production of strawberries, peas, early radishes, Irish and sweet potatoes, and other vegetables and fruits requiring a light, easily drained soil. It should also prove admirably adapted to bright tobacco. In Perquimans county, besides corn and cotton, peanuts are also grown to a considerable extent upon this phase of the type.

The following table shows the results of mechanical analyses of typical samples of the soil and subsoil of the Norfolk fine sandy loam. The figures represent the averages for five samples each of the soil and the subsoil.

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
12457, 12455, 12176, 11664, 12459	Soil	0.1	2.3	4.2	44.9	19.6	21.3	7.2
12456, 12177, 12458, 11665, 12460	Subsoil	.1	1.8	3.9	42.3	15.5	21.7	14.5

PORTSMOUTH FINE SANDY LOAM.

The Portsmouth fine sandy loam has an average depth of about 10 inches, and consists of a dark-gray or brownish-gray sandy loam which ranges from medium to fine in texture and contains considerable silt. It is for the most part mellow and loose enough in structure not to clod to any great extent. The subsoil is heavier and much more compact, and contains a larger percentage of silt. The color is an intermixed light and dark gray, mottled with yellow and brown iron stains. At 30 inches or less, looser, sandier material of a uniform light-gray color is commonly encountered.

In some parts of the area mapped, in the vicinity of Yeopim and along the Bear Swamp road, the soil is looser and deeper than usual and the subsoil is better oxidized, as indicated by a more yellow color. It is recognized that in these localities some areas of Norfolk fine sandy loam exist, but they are too small and irregular in outline to permit of mapping on the scale used.

The Portsmouth fine sandy loam is principally confined to the upper two-thirds of the area, though it is represented in nearly all parts of both counties, except in the river or sound necks. The type is quite frequently found abutting upon the Portsmouth loam near the margins of the pocosons. It generally occupies flat or slightly depressed areas. There is seldom any topographical relief, and the drainage is always inadequate except as effected by artificial means. In many instances areas of Portsmouth fine sandy loam are situated at some distance from natural drainage channels, and long ditches have to be dug.

The Portsmouth fine sandy loam is derived from the sediments deposited in the most recent geologic age and in the same manner as the other soils of the area. Its darker color is due to the larger amount of organic matter accumulated under poorer natural drainage conditions.

The type is adapted to the production of general farm crops, and especially to those requiring a medium heavy soil that is easy of cultivation and yet able to maintain sufficient moisture for the needs of most crops during periods of comparative drought. It is a better soil for corn than for cotton, the rather too generous supply of moisture prolonging the growth and maturity of the cotton boll too far into the season. It is well adapted to late cabbage, radishes, turnips, and other vegetables of this class, which require a rather heavy, retentive soil.

Corn is the principal crop grown, and with moderate fertilization will produce about 20 bushels to the acre. Although probably 25 per cent of the cultivated area of this type is devoted to cotton, the soil is too heavy and late and the yield is unprofitably low, except upon the highest and best drained portions of the type.

Besides pine, which occurs on all the other arable types, the natural forest growth is characterized by the presence of sweet gum and black gum. Along ditches an abundant growth of cane is characteristic of this type, and is also present, though to a less extent, in some of the lowest areas of woodland.

The following table gives the results of mechanical analyses of typical samples of the Portsmouth fine sandy loam, the figures representing the average of two samples each of the soil and the subsoil.

Mechanical analyses of Portsmouth fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
12471, 12467	Soil	0	0.5	2.8	59.8	8.6	14.8	13.1
12468, 12472	Subsoil	0	.4	2.5	55.2	6.8	15.7	19.3

PORTSMOUTH SILT LOAM.

The Portsmouth silt loam averages about 9 inches in depth, and consists for the most part of a friable silt loam of a very uniform texture. In some localities, however, the soil becomes somewhat coarser, and in a few instances even contains about 20 per cent of very fine sand. The predominant color is a medium gray, mottled sometimes with lighter and darker shades. The subsoil, extending from 9 to 36 inches, is a heavy gray silt loam, mottled with drab and with buff and brown iron stains. The subsoil, especially in its lower depths and nearer the surface in the heavier phases of the type, sometimes exhibits a greasy, waxy consistency, showing the presence of considerable clay.

The Portsmouth silt loam is by far the most uniform of any of the soil types in this survey in all its characteristics, the color, texture, and drainage exhibiting a striking sameness in the different areas where it is encountered. In one or two localities, however, as over a limited area about 5 miles northwest of Elizabeth City and again southeast of Newhope, in Durants Neck, the surface of the soil has a rather more ashy gray appearance and bears a close resemblance to the Leonardtown loam in general color, mottling, and texture. About 4 miles south of Elizabeth City there is a local area of the type which presents a considerably darker surface color, the texture, however, remaining about the same. The same dark appearance is also present near the boundary lines between this type and the Portsmouth loam.

The Portsmouth silt loam is the most extensive type in the area, constituting 37.3 per cent of the whole. It occurs in nearly all parts of both counties, but is most extensively and uniformly developed in the sound necks between Pasquotank and Little rivers and between Little and Perquimans and Perquimans and Yeopim rivers, extending out on each of these necks to Albemarle Sound. In the latter positions, as will be seen by reference to the map, it is found in broad connected areas, and save for the presence of Swamp and a narrow strip of Norfolk silt loam along the streams it makes few contacts with other soils.

Except along some of the stream margins, the topography appears wholly flat to the eye and is unrelieved by any elevations or undulations. The Portsmouth silt loam occupies a position of from 4 to 15 feet above sea level. Artificial drainage is always necessary and is usually accomplished by means of open ditches. Wide and deep roadside ditches, fringed with a sturdy and abundant growth of red cedars, are a strikingly characteristic feature of the type.

The Portsmouth silt loam was formed from the finer sediments brought down by the streams when they had their sources farther to the westward. These sediments were deposited during a more or less complete submergence of the present Atlantic coast.

This type of soil is better adapted to the production of corn, grass, the small grains, and late vegetables—such as cabbage, kale, collards, etc.—than to cotton, sweet potatoes, or those truck crops requiring a looser, sandier soil, favoring earlier maturity. Its principal use, however, is for corn and cotton. Of the former the average yield is about 18 bushels to the acre, while the latter produces a little more than half a bale.

The following table shows the results of mechanical analyses of typical samples of this soil. The figures are averages for two samples of the soil and the subsoil.

Mechanical analyses of Portsmouth silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
12475, 11757	Soil	0.2	0.2	0.6	1.9	11.9	72.6	12.4
11758, 12476	Subsoil	.0	.2	.7	3.5	11.1	67.4	16.4

PORTSMOUTH LOAM.

The Portsmouth loam consists of a black, fine-grained loam ranging in depth from 10 to 24 inches. The soil contains a small amount of the finer grades of sand, but the predominant constituent is silt, which gives to the mass its characteristic mellow consistency. The soil possesses a large amount of organic matter, and upon it weeds and wild grass attain a very rank growth, interfering with the cultivation of crops. The subsoil is generally a uniform gray or somewhat mottled silt loam of a much greater degree of compactness than the soil. From 10 to 20 per cent of clay is present, and taken as a whole the subsoil does not vary markedly from that of the Portsmouth silt loam, except that there has been less oxidation and consequently less coloring from yellow iron stains. With the exception of an increase in the sand content in some localities, there is little variation in the main characteristics of the soil in different parts of the area surveyed.

The Portsmouth loam is confined to the northern and western parts of the area, where it is distributed in large, continuous bodies. It is found well developed in a section known as "Tadmore," in the upper part of Pasquotank County, and in Bear Swamp, southwest of Hertford.

The type occupies nearly level or only slightly elevated areas, known as "pocosons," where a semiswamp condition exists. These areas are characterized by a forest growth of interspersed pine and black gum, together with some sweet gum and an occasional cypress, the undergrowth consisting of a tangled network of briers and cane, not easily penetrated.

The drainage is always deficient, and there is much standing water present during the winter months. Extensive artificial drainage is necessary before cultivation is possible. This is usually accomplished by means of wide, open ditches, which have to be a mile or more in length in some instances in order to reach natural drainage ways.

The origin of the Portsmouth loam is similar to that of other types within the area. The black color of the soil is due to the organic matter present, facilities for the accumulation of which have been unusually good in these thickly forested and deeply shaded areas.

There is little question that well-drained areas of this type are well suited to the production of onions, celery, and some of the vegetables which are grown with success and profit upon the muck soils of the North, and the exploitation of the celery industry in particular is advocated. The soil is also fairly well adapted to corn.

Although cotton is grown to some extent, and a luxuriant plant is produced, the bolls are late in maturing. The greater proportion of the cultivated area of this type is devoted to corn, which yields on an average about 25 bushels to the acre. Irish potatoes are grown to some extent and yield well. The greater proportion of this type has not been brought under cultivation.

The following table gives the results of mechanical analyses of typical samples of the Portsmouth loam, the figures showing the average composition of two samples each of the soil and subsoil:

Mechanical analyses of Portsmouth loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
11666, 12463	Soil	0.3	1.3	1.5	13.5	20.7	44.5	18.2
11756, 12464	Subsoil	.2	.4	1.0	8.9	20.0	44.3	24.9

NORFOLK SILT LOAM.

The soil of the Norfolk silt loam, to an average depth of about 9 inches, is a pale yellowish to reddish-brown silt loam, exhibiting a rather coarser texture than the Portsmouth silt loam. The subsoil is a brownish-yellow, heavier, more compact silt loam, which is sometimes mottled to a slight extent with gray streaks. Immediately along the banks of some of the smaller streams and swamps, where the roads have cut down 3 or 4 feet, this subsoil works up like a yellow clay. Very often, however, a tendency to greater looseness is shown in the lower depths of the subsoil. A section along

Perquimans River showed a uniform grade of loose yellow fine sand at 4½ feet, extending to 11 feet or more.

The type is best developed along New Begun Creek, in the vicinity of Weeksville, in Pasquotank County, and along Yeopim River, Yeopim Creek, and Suttons Creek, in Perquimans County, and forms about 3 per cent of the entire area. It occurs as a narrow band, having an average width of about one-fourth mile along these streams.

The surface is very nearly flat, exhibiting only slight undulation at its nearest approach to the streams.

Although the natural subsurface drainage is better on this type than on the Portsmouth silt loam, ditching is necessary to carry off all the surplus water and leave the soil in the best condition for cultivation.

The Norfolk silt loam is the result of the deposition of the coarser silt and finer sands along the margins of the streams when the land occupied a lower elevation than at the present time.

This type of soil is adapted to general farming purposes and to many of the truck crops. Its position near the water, especially of such bodies as lie along Perquimans River and the mouths of the larger creeks, guarantees comparative freedom from late frosts and gives it a value for trucking equal to that of a looser, warmer soil lying farther inland. It is a better cotton soil than the Portsmouth silt loam, and it also makes very good corn land. It is not so good for peanuts as the Norfolk fine sand and Norfolk fine sandy loam, though fair yields are produced.

Cotton yields about three-fourths bale to the acre, and even more with high fertilization. A large percentage of the type is devoted to the production of corn, which yields on an average about 20 bushels to the acre.

The following table shows the results of mechanical analyses of typical samples of the Norfolk silt loam, the figures being the average of the determinations on three samples each of the soil and subsoil:

Mechanical analyses of Norfolk silt loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
12443, 12447, 12445	Soil	Tr.	0.7	1.9	10.6	23.1	53.9	9.3
12448, 12444, 12446	Subsoil	0	.3	1.0	7.2	18.7	54.5	18.1

SWAMP.

The Swamp mapped in Perquimans and Pasquotank counties may be divided into two classes, the river swamps and the southern edge of the Dismal Swamp, including the interiors of the large pocosons, like the "Desert" of Pasquotank County. The soil consists of a fine gray mud in the river swamps, while in the pocoson phase it is a fine-grained black mud extending to a depth of 3 feet or more. Along the upper and narrower parts of the Perquimans and Pasquotank rivers it ranges from one-fourth to 1 mile in width. Associated with these are many narrow tributary swamps in all parts of the area, which are nearly dry during the summer season and show no definite stream channels, but during the rainy months of the winter are filled with an accumulation of surface water, which does not drain off until late in the spring. These river swamps are characterized by a growth of cypress and gum, the former predominating. No cypress is present on the higher part of the pocoson phase, such as the "Desert," the original forest growth consisting mainly of pine. Much of the merchantable pine has been cut off in the last few years, leaving standing a forest of pine poles in an undergrowth of cane, briers, and gallberry bushes. As the "Desert" is more deeply penetrated in the direction of the Dismal Swamp the gums make their appearance, together with occasional specimens of cypress and juniper, the growth of pine at the same time becoming more scattering. There is much standing water in these pocosons during the winter, so that logging operations are carried on with difficulty, but during the summer months they become dry enough for oxen and horses to be used to draw the logs to the tramroads.

It is probable that at some time in the future these inland swamps will become valuable for agriculture, but until an expensive system of large main and lateral ditches is constructed they are valuable only for the pine and gum which they produce.

AGRICULTURAL METHODS.

The agricultural methods of this part of North Carolina are those common to many of the States where negro labor is the only kind to be obtained, and where quite a large proportion of the land is worked under the tenant system. Shallow plowing is the rule, and is usually accomplished with a 1-horse implement, the land being thrown into high ridges in the cultivation of both corn and cotton.

It is the practice of some of the farmers to drill in stock peas (or soy beans) after corn receives the last cultivation. Then, after the corn is harvested, the hogs, of which a great many are annually raised in the area, are turned in and allowed to fatten upon the ripe and standing peas. Peanuts are considered an even more economical feed for hogs than stock peas, and the crop is said by many to pay the expense of cultivation and harvesting in hog feed and vines for fodder.

Commercial fertilizers are in general use throughout the area, comparatively little barnyard manure being made. The practice exists of composting in the fields or near the stables, in the early spring months, what little manure is collected, along with leaves and some soil, this compost being either plowed in when the land is prepared or distributed as a top dressing after the cotton or corn is planted.

The cornstalks are left standing in the fall after the ears are stripped from them, and these, together with the cotton stalks, are generally broken down in the spring with a club, or chopped down with a heavy grub hoe. For the accomplishment of this work a very profitable implement is lately coming into use in the shape of a cylindrical stalk cutter, designed to be drawn over the fields by two horses, cutting the stalks one row at a time into foot lengths, so that they can be easily turned under by the plow. This implement effects a great saving in both time and labor and should come into more general use.

The vehicle in almost universal use in the area both for hauling loads on the farm and for general road use is the high two-wheeled cart. This "Perquimans cart," as it is often called, needs but a simple harness consisting of a collar and hames, connected directly to the cart shafts by short draft chains in place of the ordinary traces. The weight of the shafts is carried by a broad, heavy, leather strap, resting in a simple wooden saddle at the back and passing entirely around the animal. The cart is of light draft and is very useful about the farm and might be profitably copied in other sections of the country, but for the hauling of produce to market and other heavy road work it is an expensive vehicle, requiring for the same load double the number of drivers as the four-wheeled wagon.

AGRICULTURAL CONDITIONS.

During years when fair yields are received and crops can be sold at a profitable margin, the farmers of the area express little discontent, are able to meet their store debts with little difficulty, and enjoy a fair degree of prosperity. On the other hand, when prices are low, as the result of overproduction or the manipulation of the market by speculators, the resulting hardships are keenly felt. Some of the owners of large farms live in roomy, well built, and comfortably furnished houses, while in some parts of the area the general appearance of the homes of some of the poorer farmers and negro tenants is uninviting. Houses, outbuildings, and fences all present a dull gray appearance, having received neither paint nor whitewash in many years.

While some of the farmers have large holdings of land—from 200 to 1,000 acres or more—according to the Twelfth Census only about 44 per cent of the farms of the area are worked by their owners, the remainder being let out to tenants. The usual arrangement is for the owner to furnish all tools, teams, and seed, and to receive from the tenant one-half the crop, although in a few cases a cash rental per acre is charged.

According to statistics the average size of the farms in Perquimans and Pasquotank counties is about 75 acres, which includes many small farms owned by the more thrifty negroes. The partition of the larger estates into farms of smaller acreage would result in a more thorough system of agriculture and would be of distinct advantage to the community.

Almost sole dependence must be placed upon the negro race for farm laborers. They are usually hired by the day, the men receiving from 50 cents to $1 without board.

The figures of the Twelfth Census show that about 50 per cent of the entire area was at that time devoted to the production of corn, while the acreage given to cotton ranged from 5 per cent in Pasquotank County to 14 per cent in Perquimans County. It is believed that during the past year (1904) cotton was planted on nearly 20 per cent of the cultivated land of the area, though the amount will undoubtedly be decreased in 1905. This area forms practically the northern limit of the cotton belt, and unless the farmers are able to secure better and more stable prices the production of the crop will be to a large extent unwillingly abandoned within the next few years. Although over 1,000,000 pounds of rice were reported in 1900, less than half a dozen acres were grown during the past year, due to the impossibility of competing with more southern rice sections better adapted to its culture. Peanuts form an important crop with some of the farmers in the more sandy parts of Perquimans County, and as a crop they are particularly well adapted to the Norfolk fine sand and Norfolk fine sandy loam. Up to the present time comparatively little trucking has been engaged in, with the exception of relatively unimportant crops of sweet and Irish potatoes and early peas, for shipment to the northern markets. Few berries or fruits are grown except for home consumption. Save for a little milk peddled in Elizabeth City no dairying industry exists. The cattle are native scrubs, small, poorly cared for, and often underfed, procuring their own living in the woods, swamps, and fields nearly the whole year through. Hogs are quite extensively raised in all parts of the area. They forage for themselves to a large extent, and up to the time when they are ready to be fattened require comparatively little care and are very profitable.

The suitability of the Portsmouth loam and Portsmouth silt loam for corn is well recognized in the area. The most striking instance of this is seen in the "Tadmore" district of the upper part of Pasquotank County, where corn growing amounts to specialization. Irish and sweet potatoes and peanuts are generally grown upon the sandier parts of the farms, while the soils of intermediate texture are usually chosen for cotton.

The eastern counties of North Carolina, including the area surveyed, seem to be fitted by nature, in respect of soil and climatic conditions and geographical location, for a general trucking industry. Soils of different degrees of retentiveness and covering the whole range of textural characteristics, from the loosest sand to the finest silt loam, are found situated both inland and along the broadened estuarine portions of both Pasquotank and Perquimans rivers, where the influence of frosts is least felt. The Norfolk fine sand and the loose phase of the Norfolk fine sandy loam are excellent soils for strawberries and the earliest summer vegetables, such as peas, early Irish potatoes, snap beans, asparagus, melons, etc., while the well-drained areas of Portsmouth fine sandy loam and the looser phase of the Portsmouth silt loam afford good locations for cabbage, cauliflower, kale, spinach, and late potatoes. The black, fine-textured soil of the Portsmouth loam offers opportunities for the development of a profitable celery and onion industry.

Railroad transportation in the area is furnished by the Norfolk and Southern Railroad, which passes through the center of both counties, with Edenton, N. C., at one terminus and Norfolk at the other. Elizabeth City and the northern edge of Perquimans County are also served by the Suffolk and Carolina Railroad. The Norfolk and Southern company operates a very comfortable and commodious line of steamers between Elizabeth City and Newbern, touching at Roanoke Island and Oriental, while other steamers carry freight and passengers between Elizabeth City and Norfolk, both by way of the upper Pasquotank River and the Dismal Swamp Canal and by the Currituck Sound route. Numerous sound schooners and other small sailing craft come up Pasquotank River to Elizabeth City, some bringing farm produce or fish and oysters in exchange for general merchandise, and others engaged in the lumber and shingle trade. Perquimans River is navigable for a number of miles above Hertford, and an important lumber industry is established at that point. At the present time, however, there are no steamers connecting Hertford with any of the Albemarle Sound ports, and with the exception of an occasional fishing or oyster boat there is very little traffic on the lower part of the river.

The wagon roads of the area are for the most part conveniently laid out, well drained, and kept in a good state of repair throughout the year. A system of turnpiking and bridging at the river-swamp approaches to the main bridges and ferries over the upper portions of Perquimans and Pasquotank rivers would greatly facilitate travel during the wet winter months, when the water is often very high and the mud deep.

The county seats of Perquimans and Pasquotank counties are Hertford and Elizabeth City, respectively. The former has a population of about 2,000, the latter 10,000. There are no other towns of more than 300 population within the area, so that when the small local demand for farm produce is supplied the bulk of the shipments are made to the northern markets by way of Norfolk, which is about 53 miles from Elizabeth City and 70 from Hertford. Packages of truck would reach New York via Norfolk and the Old Dominion Line in about twenty-four hours, and in slightly less time by the all-rail route.

SOIL SURVEY OF DUPLIN COUNTY, NORTH CAROLINA.

By **ALDERT S. ROOT** and **LEWIS A. HURST.**

LOCATION AND BOUNDARIES OF THE AREA.

Duplin County, located in the eastern part of North Carolina, comprises an area of 527,488 acres, or about 824 square miles. It has for its immediate northern boundary Wayne County; Lenoir and Jones lie to the northeast; Onslow directly east; and Pender and Sampson on the south and west, respectively. The boundaries of the area are all imaginary lines, except where the Northeast River separates Duplin and Wayne for about 10 miles distance, and on the south, where Rockfish and Doctors creeks mark the line for a few miles. There are no large towns in the area, Warsaw, the largest, having a population of 576 in 1900. Kenansville, the county seat, is located in the west-central part of the area and is 7 miles distant from Magnolia and 8 miles from Warsaw, the two nearest railroad stations. The population of the entire county is 22,405.

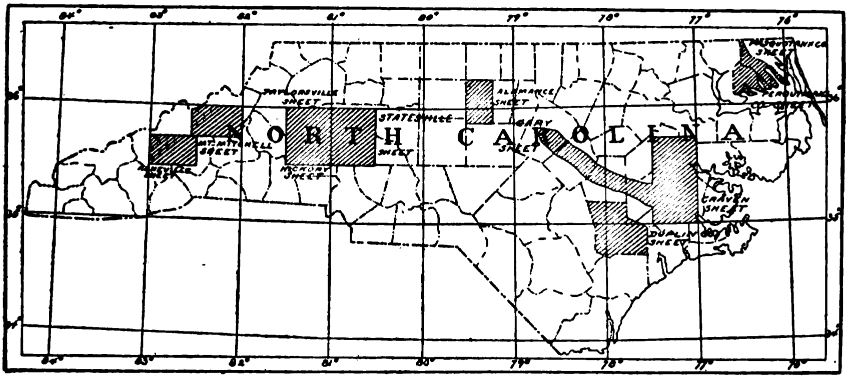

FIG. 10.—Sketch map showing location of the Duplin County area, North Carolina.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Duplin County, N. C., was established from a part of New Hanover County during the legislative session of 1749–1750, and originally comprised what is now Duplin and Sampson counties, maintaining these boundaries until about 1784, when Sampson was established.

The first settlement of this section was made about 1737 upon a grant of about 70,000 acres of land, lying largely between the Black and Northeast rivers. From the beginning the settlements were very widely scattered, though chiefly along the streams, as there were no railroad facilities at that time. A very old settlement, which was one of the first in this territory, was at Sarecta, on the Northeast River, about 8 miles east of Kenansville. Another equally as old, if not older, settlement was at the present site of Kenansville, which is now near the center of Duplin County. This was the center of the early settlements of the county and is marked now by the old Routledge graveyard, which is about 1 mile east of Kenansville. At this place there was established by the legislature in 1785 the Grove Academy, which was one of the earliest institutions of learning in eastern North Carolina, and continued to be one of the leading schools until after the civil war. In the northwestern part of the county, on Goshen Swamp, near the present town of Faison, there was established another considerable settlement which began as early as 1740, and Presbyterian missionaries were there as early as 1742. Just west of the Wilmington and Weldon Railroad, near the present town of Warsaw, there was also a strong settlement, which became the county seat of Duplin County before Sampson was cut off from it. These and many other settlements were so scattered throughout the county that the different sections made about the same progress.

The original industries of the county were largely agriculture and stock raising, and the first settlers obtained their support chiefly from this source. The entire section was once covered with forest, largely longleaf pine, and later much attention was given to the manufacture of tar and turpentine, and for more than fifty years this industry was the chief source of income, continuing to be so until about 1890, when the resources of the longleaf pine forests became almost exhausted. In addition to the manufacture of naval stores, the business of cutting timber and floating it in rafts down the Northeast River to Wilmington, where it was marketed, was also extensively engaged in. This industry has likewise almost ceased, on account of the fact that the timber supply has either been exhausted or has been purchased by lumber companies.

Owing to the changed condition in the turpentine and timber interests, the entire attention of the people of Duplin, about 1890, began to be directed toward agriculture. Since that time there has been a most wonderful development along the Wilmington and Weldon Railroad, which was built between 1830 and 1836, where there has grown up a great trucking interest, which has caused this section to become widely known. The chief product is the strawberry, though Irish potatoes, cantaloupes, watermelons, and various other products are grown in abundance.

Magnolia for fifteen years has had the largest tuberose industry in the world. Hundreds of acres of tuberoses and other bulb plants are cultivated annually in various parts of the county, and the bulbs are shipped to the northern and foreign markets.

During the last ten years tobacco has been grown in all sections of the county, but most abundantly east of the Northeast River. This was the first section of the county to grow it to any extent, but it is seriously handicapped by the long distance to any railroad.

This section has also become an important cotton-growing section, and to-day there are thousands of acres cultivated in tobacco and cotton which only fifteen years ago were covered with pine forests, valued mainly for turpentine.

If during the next fifty years the development of the agricultural interests shall continue as it has during the last fifteen, Duplin County will be one of the most prosperous agricultural sections of the country, the people being almost exclusively occupied in some kind of agriculture.

CLIMATE.

The following table, compiled from records of the Weather Bureau, gives the normal monthly and annual temperature and precipitation, respectively, at Sloan, which is located in the southern part of Duplin County, and at Goldsboro, about 17 miles north of Faisons. These observations will suffice to represent fairly accurately the conditions for the whole area.

Normal monthly and annual temperature and precipitation.

Month.	Sloan.		Goldsboro.		Month.	Sloan.		Goldsboro.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	*°F.*	*Inches.*		*°F.*	*Inches.*	*°F.*	*Inches.*
January	44.8	3.31	42.6	3.06	August	78.1	7.45	78.3	7.27
February	44.5	4.41	47.3	3.42	September	73.8	3.37	72.8	4.80
March	53.4	4.06	52.0	4.77	October	61.2	4.90	61.6	3.20
April	61.2	3.51	60.6	4.76	November	54.0	2.89	51.9	2.40
May	70.0	4.09	69.6	4.99	December	46.5	3.15	44.4	3.63
June	76.0	4.88	77.2	5.18	Year	61.7	52.17	61.5	53.56
July	77.1	6.15	79.8	6.08					

The highest mean temperature in the last year (1904) was 100°, on August 27, and the lowest was 14°, on November 28. The dates of the last killing frost in spring and the first in fall, covering a period of eight years, are shown in tabular form below:

Dates of first and last killing frosts.

Year.	Sloan.		Goldsboro.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1896	Apr. 5	Oct. 19	....	Oct. 19
1897	Apr. 21	Nov. 12	....	....
1898	Apr. 8	Nov. 21	....	Nov. 20
1899	Apr. 6	Nov. 7	....	....
1900	Apr. 5	Nov. 10	Apr. 6	Nov. 10
1901	Mar. 7	Nov. 7	Mar. 17	Nov. 7
1902	Apr. 2	Dec. 6	Apr. 2	Nov. 28
1903	Apr. 5	Oct. 27	Apr. 5	Oct. 27
Average	Apr. 4	Nov. 10	Mar. 31	Nov. 8

There is some variation in climate within the area. Strawberries are shipped about a day earlier for every 10 or 15 miles traveled southward. The prevailing winds are, generally speaking, from the southwest in summer and from the northwest in winter. Fogs are more prevalent in the fall of the year. Light snow falls nearly every winter, sometimes only a trace, but it rarely remains for more than a day or two. The area is one of high relative humidity.

PHYSIOGRAPHY AND GEOLOGY.

There is a gradual fall in the surface of Duplin County from north to south. The topography of the northern part is undulating and rolling, passing gradually with advance toward the south and east into a more level plain, with relatively poor drainage conditions. A more concise idea of the elevations of the county can be had by noting the height above sea level of the following points along the Atlantic Coast Line Railroad, which will show a section of the most elevated portion: Faison, 159 feet; Warsaw, 155 feet; Magnolia, 140 feet; and Wallace, 54 feet.

The relation of topography to the character of soils is evident even to the untrained eye; in fact, the surface conditions, particularly as affecting drainage, are the important factor in the separation of the types into the two distinct series of soils found within the area. The many high divides in the county and the rolling and well-drained uplands adjacent to stream valleys are occupied by the Norfolk series, and the broad expanse of low, wet lands, occurring most extensively on the almost level plain referred to, are made up of soils of the Portsmouth series and the numerous savannas, pocosons, and swamps which form an important part of this section.

The Northeast Cape Fear River, following a general north-and-south direction, affords drainage for the entire county, except where the high watershed between Warsaw and Kenansville directs Stewarts Creek and a few of its tributaries to the westward into Sampson County. Goshen Swamp, a stream of about the same magnitude, removes the surplus of water from the entire northeast corner of the county. This stream is flanked by a swamp covered with a dense growth of cypress and gum, and varying in width from one-fourth mile, where it enters the county, to a mile at its confluence with the Northeast River. A network of smaller streams interlaces the area. Almost always they have their sources in bodies of the Portsmouth soils or in the pocosons.

The largest of the streams have noticeable terraces, low and rather ill-defined, and the soils in many cases irregularly follow their contours. In the flood plains of many of these, especially east of the Northeast River, there occur valuable deposits of marl at a depth of 2 to 4 feet, the largest beds probably being found along Muddy Creek. This is extensively utilized as a soil improver upon the low, poorly drained lands.

The geological origin of all the soil types in the county is the same. The area, occurring in the Atlantic Coastal Plain, owes its formation to marine deposition of materials transported from the Piedmont Plateau and Appalachian Mountains. Since this deposition and the elevation of this region above sea level much of the soil has been modified by wet, swampy conditions.

SOILS.

Two general series of soils exist within the area—those which occupy the well-drained uplands, namely, the Norfolk fine sandy loam, Orangeburg fine sandy loam, and Norfolk fine sand, and those which are found in low, depressed areas, giving rise to the Portsmouth fine sandy loam, Portsmouth sand, Portsmouth loam, and Swamp. All of these types have been correlated with soils mapped in other areas and all are characteristic soils of the Atlantic seaboard.

The extent of these several soils is shown in the following table, the relative percentage of each to the total area of the county also being given.

Areas of different soils.

Soil type.	Acres.	Per cent.	Soil type.	Acres.	Per cent.
Norfolk fine sandy loam	180,032	34.2	Portsmouth loam	8,448	1.6
Norfolk fine sand	117,440	22.2	Orangeburg fine sandy loam	7,616	1.5
Swamp	109,824	20.8	Total	527,488	
Portsmouth fine sandy loam	66,112	12.5			
Portsmouth sand	38,016	7.2			

NORFOLK FINE SANDY LOAM.

The Norfolk fine sandy loam covers a greater acreage than any other soil type in Duplin county, comprising 180,032 acres, or 34.2 per cent of the entire county. A large proportion of it is as yet undeveloped, though the earliest of the settlements were made upon it. Two distinct phases of the type are presented in this area, one differing from the other to such extent as to justify separate discussions.

The greater part of the type in Duplin county, however, consists of a loose gray fine loamy sand, grading into yellow sandy clay at any depth between 12 and 36 inches, usually at 20 inches. Where the soil occurs in slightly depressed and low, level, but well-drained areas it is more compact, has larger water capacity, more organic matter, and the soil grains appear more rounded; but in areas where the sand is deeper than 20 inches the soil, owing to its loose structure, suffers often from drought.

There are only a few parts of the county where the Norfolk fine sandy loam does not occur. The largest unbroken body is found north and east of Bowdens. The greater part of the type occupies undulating and gently rolling areas, and the natural drainage conditions are such that but a small proportion requires ditching, even to remove the surplus water. The soil is of sedimentary origin, the particles constituting it having been transported from other regions and deposited in shallow water.

The Norfolk fine sandy loam is adapted to a diversity of crops, but at present much of the type is devoted to corn, cotton, and tobacco. The production of cantaloupes and lettuce is becoming more important in the area, and these are grown almost altogether upon this soil. Tobacco is grown more extensively and with better results than upon any of the other soil types, the leaf obtained being of the desired color and texture and the average yield about 700 pounds per acre. Potatoes yield at the rate of 30 barrels per acre, cotton one-third to one-half bale, and corn 10 to 20 bushels. The cowpea should be more extensively cultivated on account of its qualities as a fertilizer and for the purpose of adding organic matter to the soil.

The other phase of the Norfolk fine sandy loam, of which some detailed description should be given, possesses characteristics easily distinguishable from the main part of the type in this area. The surface few inches of soil is a fine sandy loam, varying in color from almost black to yellowish brown proportionately as the organic matter is greater or less. Underlying this and at a depth of from 12 to 20 inches is a light-yellow fine sandy loam, becoming heavier with increase in silty material, beneath which rests a sticky, plastic yellow clay, extending to 3 feet or more. At greater depths beds of sand and clay occur in alternate strata.

This phase of the type occupies level or almost level areas, but with sufficient elevation for streams to carry off the surplus water and open ditches to complete the drainage. When properly ditched there is no fear of excessive moisture, and plowing can take place a few hours after a heavy rain. The most extensive occurrence of this phase of the Norfolk fine sandy loam is found just north of Goshen Swamp, around the town of Calypso; an irregular body of considerable size also occurs about Warsaw, where it frequently alternates with the Portsmouth fine sandy loam, and west of the town of Teacheys is a tract occupying a broad divide in the vicinity of Beulaville.

On account of its natural fertility, its relative great power of retaining fertilizers, its naturally moist condition, which guards against drought, and the great diversity of crops to which it is adapted, this phase of the Norfolk fine sandy loam is regarded as the most valuable soil in the area. Besides the crops heretofore enumerated, to which the Norfolk fine sandy loam is well adapted, this phase of the type has been found well suited to the cultivation of strawberries and has given the best results with this crop of any of the soils in the county. The strawberry plant, flourishing best in a moist habitat, finds an ideal condition for its growth and propagation upon this soil, and very satisfactory yields, both in quality and quantity, are obtained. When properly fertilized an average yield of 100 crates per acre is secured. Beans, cabbage, cucumbers, peppers, and other small truck crops would do well. The yields of Irish potatoes, corn, and cotton are much higher on this phase than on the main part of the type. The average per acre for potatoes is about 50 barrels; for corn, 20 to 25 bushels, and for cotton, three-fourths of a bale.

The most valuable timber growth in the county is seen upon the Norfolk fine sandy loam, and consists of shortleaf pine, scrub oak, and persimmon.

The following table gives the results of mechanical analyses of soil and subsoil of this type. The figures represent the average of separate determinations on four samples each of the soil and the subsoil.

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
12580, 12582, 12586, 12590	Soil	0.1	2.3	4.6	41.6	21.9	17.6	11.7
12581, 12591, 12583, 12587	Subsoil	.1	3.7	5.8	31.8	16.6	15.4	26.3

NORFOLK FINE SAND.

The Norfolk fine sand consists of 4 to 6 inches of a gray loose sand a little darker than the subsoil, which to a depth of 36 inches is a yellow or white sand. The slight proportion of organic matter accounts for the darker color in the first few inches of the surface soil. The sand in both soil and subsoil is of medium to fine grade and markedly lacks coherence. At 36 inches or deeper a yellow sandy clay is to be found, the same that occurs as the subsoil of the Norfolk fine sandy loam, the chief difference between these two types being in the depth of the superficial mantle of sand. A finer phase of this type is found in a few local spots, notably 3 miles northwest of Warsaw and a few acres along Rockfish and Muddy creeks, but occurring only as patches of limited extent they could not be shown on a map of the scale used in this survey.

The Norfolk fine sand comprises 117,440 acres, or 22.2 per cent of the entire area of the county, and is second in extent only to the Norfolk fine sandy loam. It is found in all parts of the county, in general following the trend of stream and river courses and widening out in certain sections to form high rolling divides with gentle slopes. The largest bodies are to be found west and northeast of Magnolia, west of Kenansville, and forming the major portion of the high watershed between the Northeast River and Goshen Swamp. Also large tracts are to be encountered in the extreme northeastern corner of the county. The topographic features of the area covered by it are distinctly marked. It occupies the undulating and gently rolling uplands, having a good fall, and this, combined with its loose, porous nature, guarantees perfect drainage, so that even after the heaviest rains cultivation can be undertaken within an hour or two.

Much of the Norfolk fine sand type is deforested of the longleaf pine which once flourished upon it, but on account of its low agricultural value only a small proportion is farmed. On account of the leaching which takes place as a result of the porosity of the soil, it is necessary to use large quantities of fertilizer to obtain good results. When properly handled the soil can be made to grow light truck crops, and is especially adapted to watermelons, which are cultivated in a limited way. Corn, cotton, and tobacco are the principal crops produced at present. Peanuts, for fattening hogs, are grown on many of the farms. The quality of the tobacco is very good, the leaf having the desired light color and fine texture. Tobacco yields an average of 650 to 700 pounds per acre, corn 10 bushels, and cotton one-third bale.

The most economical means of handling this soil is in the cultivation of cowpeas, which flourish particularly well upon it. By turning both roots and vines under and allowing them to decay, beneficial results will be obtained, both through the addition of needed organic matter and in giving more body to the soil. The application of lime will also tend to make the loose sand grains cohere and thus improve the texture.

Mechanical analyses of samples of the Norfolk fine sand are given in the following table, the figures representing the average of determinations for two samples each of the soil and the subsoil.

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
12592, 12596	Soil	0.6	9.6	11.2	62.0	9.8	2.9	3.8
12593, 12597	Subsoil	.5	10.4	12.2	60.8	9.2	2.7	4.2

ORANGEBURG FINE SANDY LOAM.

The Orangeburg fine sandy loam, on account of its limited representation in the county, requires but a brief discussion. The surface soil is a medium to fine brown or gray sandy loam, grading at 12 to 20 inches into a sticky pastic red sandy clay. Its agricultural value is about the same as the Norfolk fine sandy loam, and, except for the properties of the subsoil, it does not materially differ and could not be differentiated from that type. The difference in the subsoils, which is mainly one of color, is believed to be due to a difference in the state of the iron contained in them, that in the Orangeburg fine sandy loam being in a more advanced stage of oxidization.

The type occurs in all cases adjacent to stream and river courses, the widest areas being found along Goshen Swamp for 8 or 10 miles after it enters the county. The drainage features are in all cases good, occupying as it does the rolling uplands along waterways.

The soil particles forming the Orangeburg sandy loam have been transported from the region to the northwest and deposited in water. In immediate proximity to stream beds gravelly areas frequently are to be seen, and irregular stratifications of these are in evidence in the subsoil in such cases.

Shortleaf pine and scrub oak constitute the chief timber growth. The largest part of this type, however, is cleared and under cultivation, and is in almost all cases used in the production of cotton and corn. Some tobacco is grown, but where the subsoil approaches the surface the leaf is darker in color, heavier in texture, and contains more woody fiber, and thus is inferior to the product on some other of the soils found here. Corn yields 12 to 25 bushels and cotton one-third to one-half bale per acre.

The average results of mechanical analyses of two samples each of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
12598, 12600	Soil	0.8	7.9	7.9	43.6	19.1	12.0	8.2
12601, 12599	Subsoil	.5	6.4	6.9	35.8	14.0	9.7	26.7

PORTSMOUTH FINE SANDY LOAM.

The surface soil of the Portsmouth fine sandy loam, to a depth of from 6 to 8 inches, consists of a black to gray fine sandy loam, in places having the properties of a loam on account of the large proportion of organic matter which it contains. Occupying a lower position than the adjacent soils, the finer grades of sand have been largely transported and deposited in this type, and as a result the sand content is chiefly of the finer grades. Underlying the soil and extending to a depth of 24 inches, a wet, sticky, sandy loam or sandy clay is encountered, gray in color, and somewhat coarser in the grade of sand. At 36 inches the soil is usually in a saturated condition.

Occasionally ferruginous crusts are found in local spots at a depth of 12 to 24 inches, and blue marl at a depth of 3½ to 4 feet.

The Portsmouth fine sandy loam is found generally distributed throughout the county in tracts varying from a few acres to several square miles in extent. In these larger bodies ridges of the Norfolk fine sandy loam and Norfolk fine sand frequently occur, so that a large irregular though connected body of the Portsmouth fine sandy loam is shaped. A dense growth of gall bushes, with scattering gums, bays, and shortleaf pine, constitutes the timber growth.

Since the subsoil of the Portsmouth fine sandy loam is quite impermeable, and the mean fall toward the ocean is not much more than a foot to the mile, and as the type occupies depressed areas, it would be natural to expect the prevailing poorly drained and water-logged conditions. This is the main feature distinguishing this and the other soils of the Portsmouth series from those of the Norfolk series, as both are essentially the same in their origin, having been laid down in water at a time when this section was experiencing a series of inundations. In the case of the former series, since their deposition the materials have been modified by standing water and swamp conditions, and the processes of aeration and oxidation, which are essential for the preparation of the soil for most crops, have been almost entirely wanting. Thorough drainage alone can remedy this, but when it is supplied large tracts can be reclaimed from their present wet conditions and converted into soils of remarkable productiveness. The application of lime on such soils has also been recommended, both to correct acidity and to render the soil particles less cohesive, thus assisting the downward passage of water.

Certain varieties of strawberries thrive best upon this soil when drained, and, with the exception of the acreage devoted to these, but little of the Portsmouth fine sandy loam is now utilized for agricultural purposes. Tuberoses, dahlias, and cannas give good results. Strawberries yield an average of 100 crates per acre; tuberoses, 20,000 bulbs; dahlias, 8,000 (with 4,000 reserved for the next season's planting), and cannas, 20,000. These yields are secured only when fertilizers are used. The liability of the Portsmouth fine sandy loam to bake in dry seasons makes the Norfolk fine sandy loam the more desirable type for the production of strawberries. On the other hand, excellent results have attended the cultivation of cabbage, onions, spinach, etc., upon the Portsmouth fine sandy loam, when adequately drained, in other localities where the climatic conditions are practically the same as in Duplin County.

The average results of mechanical analyses of two samples each of the soil and subsoil of the Portsmouth fine sandy loam are shown in the following table:

Mechanical analyses of Portsmouth fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
12606, 12608	Soil	0.2	3.9	5.7	55.4	11.8	10.9	12.2
12609, 12607	Subsoil	.3	5.8	7.5	47.5	10.2	8.4	20.3

PORTSMOUTH SAND.

The Portsmouth sand has for its surface soil a black or brown sand 6 to 12 inches in depth and containing so much organic matter that in cases it has the properties of a sandy loam, or even loam. The sand is quite uniformly of medium texture. The character of the subsoil depends somewhat upon the position of the areas and the extent to which they have been subjected to wet conditions. In the lower depressions the proportion of organic matter in the soil is apt to be greater, and here the resultant acids have permeated the subsoil, imparting a dark-gray or drab color to the wet sand, while in cases the subsoil consists of a mottled white or light-gray sand. The sand of the subsoil varies from fine to coarse grades, or about the same as in the soil. At 24 to 36 inches the characterizing feature of the type occurs—a white sand, very impervious in character—and at this depth the maximum water content is generally reached.

The growth which always characterizes this type consists of gall bushes, and very frequently huckleberry bushes, bay, and longleaf pine, the latter occurring on the higher and drier areas of the type.

The most extensive bodies of Portsmouth sand are to be seen east of the Northeast River, where areas of several square miles occur in one continuous body. It is largely found around the sources of the many streams which constitute the drainage system of the county. Its occurrence is confined to depressed areas with deficient drainage. There is but little of this type that can not be ultimately reclaimed, should there be occasion for turning it into agricultural use, by ditching to the heads of the numerous streams which originate in it, and thus lowering the water table. At the present time, however, its reclamation would not warrant the outlay.

As in the case of the other soils of the area, the Portsmouth sand is sedimentary, having been deposited in water and subsequently elevated and modified by swamp conditions. It is unusually well adapted to the production of tuberoses, dahlias, and cannas, and fairly well suited to strawberries where adequate drainage is assured and the soil possesses a large amount of nitrogenous matter.

With the application of fertilizers the average yield of the bulb plants are 20,000 tuberose bulbs, 20,000 cannas, and 8,000 dahlias. The area cultivated for other crops is restricted. A few acres of corn and cotton are cultivated upon it. The growing of onions, cabbage, and other late truck crops have been attended with success in other localities.

The results of mechanical analyses of the Portsmouth sand are shown in the following table, the figures representing the average of determinations for two samples each of the soil and the subsoil:

Mechanical analyses of Portsmouth sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
12614, 12612	Soil	0.1	8.7	18.1	59.4	4.4	3.7	5.4
12615, 12613	Subsoil	.2	8.6	18.4	59.4	4.4	3.5	5.1

PORTSMOUTH LOAM.

The Portsmouth loam has a very limited representation in Duplin County. In origin, in many of its properties, and in the position it occupies it bears a close relation to the Portsmouth fine sandy loam, but it differs from the latter in having a heavier texture, representing areas where the subsoil approaches nearer the surface than it does in the case of that soil. The surface soil consists of a heavy sandy loam, fine sandy loam, or loam from 4 to 6 inches deep, which contains large stores of organic matter and grades into a gray sandy clay, plastic and wet, at 10 to 12 inches. This is sometimes underlain by the stratum of white impervious sand which often characterizes the soils of the Portsmouth series, this material usually being encountered at depths of 2 to 3 feet. The soil is generally saturated at about this depth also, though the conditions as to moisture vary somewhat with the seasons.

The Portsmouth loam occurs most largely in bodies of the Norfolk fine sandy loam, the bodies of largest extent in the county being found north of Calypso and between Rosehill and Teacheys, where it occupies low, level, and poorly drained areas. Though deposited in water at the same time and in the same manner as the other soil types of the area, it, like the Portsmouth sand and Portsmouth fine sandy loam, has been subject to wet conditions for many years, so that a different nature and agricultural value has been imparted to it. It supports a growth of gallberry and huckleberry bushes, pine, and, where especially wet, gum and cypress. But a few acres are under cultivation, corn, cotton, and strawberries being the crops grown. When properly ditched it would prove an especially valuable soil for the production of corn, cabbage, and forage crops.

The average results of mechanical analyses of two samples each of the soil and the subsoil of the Portsmouth loam are given in the following table:

Mechanical analyses of Portsmouth loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
12602, 12604	Soil	0.2	0.9	1.8	31.6	17.3	26.1	22.2
12605, 12603	Subsoil	.1	.7	1.1	28.5	17.3	23.8	28.2

SWAMP.

All of those areas which are subject to overflow or are in such a wet condition that they are of no agricultural value until reclaimed have been classified as Swamp, whether they occur along the streams or as level undrained tracts upon the upland. The soil in different parts of the Swamp areas varies much in character, but since it is almost impossible to penetrate many of these a separation into the various types is impracticable.

The soil in the bottom lands along stream courses is composed of alluvial deposits of a heterogeneous nature, varying in texture from a loose unproductive sand to rich heavy black loam. Much of it along the Northeast River is subject to overflow once only in every few years, and many areas are under cultivation, the heavier "mud lands" producing large yields of corn, frequently as much as 60 bushels per acre, and sometimes commanding a price of over $100 per acre. Goshen Swamp, the largest affluent of the Northeast River in the county, has bordering it a perennially saturated strip of land one-fourth to 1 mile wide, possessing but little fall to the bed of the stream and covered by a dense and valuable growth of cypress and gum. The margins of the smaller stream courses are, as a rule, of much the same character as this, though adjacent to many are found very fertile and cultivable strips of a character similar to the "mud lands" of the river. Bays, juniper, gallberry bushes, and huckleberry bushes are characteristic growths, as well as cypress and gum.

The other phase of Swamp is represented by the various savannas and pocosons which occur frequently in certain parts of the county. In the southern part of the county, and lying directly in the large bend of the Northeast River as it changes its course toward the southeast, is the Angola Bay Pocoson, about 15 square miles of which are in Duplin County. With the exception of Gum Swamp, which lies within this pocoson and includes 3,000 or 4,000 acres, the soil consists largely of a wet, somewhat mucky loam or sandy loam filled with roots and fibers and underlain by a sticky sand or sandy loam. A rank, almost impenetrable growth of underbrush, together with a good growth of pine, characterizes this area.

The depth of the water table varies with the time of year. For weeks at a time this great basin is subject to standing water, but in dry seasons the soil is saturated at 2 to 3 feet. Gum Swamp, passing in a northwest and southeast direction through the pocoson, has a heavier soil in the form of the locally called "mud lands," described above. Work has been done toward reclaiming this section of the bay by private enterprises. Only a few acres have thus far been reclaimed, but they yield excellent crops of corn.

The description of the soils of the Angola Bay proper will apply to the other smaller ones in the county, except in certain sections of the Kenan Pocoson (the second most extensive of these bodies in the area), where the soil is similar to that found in Gum Swamp.

The elevation of the floor of the Angola Pocoson has been found to be something like 30 feet, and this relatively low position, together with the underlying impervious sand, gives rise to the deficient drainage features. Most of these pocosons can be ultimately reclaimed should there be created a demand for more land to cultivate.

The timber, especially the pine, upon many of the swamp areas is very valuable.

AGRICULTURAL METHODS.

In growing the general farm crops the methods employed are not different from those in use throughout the South, and it is not deemed necessary to discuss them in detail here. More interest attaches to the several special crops that have added greatly to the wealth and prosperity of Duplin County.

Of chief importance is the strawberry, the production of which has shown remarkable development in recent years. In growing this crop the Norfolk fine sandy loam, the Portsmouth fine sandy loam, and the Portsmouth sand are the preferred soils, the first mentioned being considered the best. The plants are usually set out in July and August in rows about 3 feet apart and at an interval in the row of 14 to 18 inches. Flat cultivation is the rule, but in wet areas, usually on the Portsmouth soils, the plants are sometimes set upon ridges. Fertilizers are very generally used, in amounts varying from 300 to 2,000 pounds per acre. Two applications are usually made—one in the fall, which is worked into the soil along the sides of the rows, and one about the middle of January, along the top of the row. No protection from the winter frosts is necessary, but in the early spring, when the buds are putting forth, a pine-straw mulch is raked over the vines whenever frost seems likely to occur. This straw is allowed to remain between the rows during the picking season to keep the berries clean. After the third season the vines are plowed up, and the land is allowed to remain idle or is used for other crops for a year or two before again rebedding it to strawberries.

A plan adopted by some growers is to plant strawberries in rows sufficiently wide apart to allow the cultivation of some intermediary truck crop—such, for instance, as beans or potatoes—but this system is looked upon with disfavor by the majority of berry growers, who say that the yield and quality of the berries are impaired by such practice.

The strawberry vines have recently been attacked by a pest, the strawberry beetle, and unless checked this may prove a serious drawback to the industry. The North Carolina experiment station has suggested a remedy, and the growers should lose no time in applying it.

For the last few years the production of early lettuce has been an important special interest, and the acreage is yearly increasing. The young plants are set in beds and during the winter are protected by cheese cloth.

Another special industry which has grown up within the last fifteen years and which has attracted attention both in this county and abroad is the production of tuberose, caladium, dahlia, and gladiolus bulbs. Wet, overflowed lands, or pocoson, is best adapted to their production, and it is a remarkable fact that even upon this rich, naturally productive soil only two good crops can be grown, even though the fields be allowed to stand idle for several seasons and no matter what or how much commercial fertilizer or organic manures be applied to the soil. In the case of the two crops, the second is said never to be as good as the first. The bulbs are planted about March 15 and gathered in October and November. Thorough cultivation is absolutely necessary to obtain the best results, and during the period from May to August, when the growth of weeds is most rapid, the field should be cultivated at least once a week. Three applications of fertilizer are made at intervals during the winter. Generally this is home mixed, and composed of muriate of potash, cotton-seed meal, and acid phosphate. The quantities applied vary with the soil and the bulb grown, ranging from 500 to 1,000 pounds per acre for the tuberose, 400 to 500 pounds for the dahlia, from 200 to 2,000 for the caladium, and from 1,500 to 2,000 pounds for the canna.

In general there is little attention paid to the question of rotation of crops by the farmers of Duplin County. Those who do follow a definite system say that they derive as much benefit from this practice and subsoiling as from the fertilizers they use. The value of the leguminous crops, especially the cowpea, as a fertilizing agent is by no means generally recognized. These three matters, the rotation of crops, deeper plowing, and the use of the cowpea or other legume for manurial purposes, can not be too urgently called to the attention of the farmers of this county.

AGRICULTURAL CONDITIONS.

The agricultural conditions in the eastern and western parts of the county are very different. In the latter there has been a transformation in the system of farming with the advent and development of the strawberry and trucking industries, but owing to the lack of transportation facilities in the eastern two-thirds of the county there has been no opportunity for a like advance, and the resources are but poorly developed, except in certain settlements, where the cultivation of cotton, corn, and tobacco engages the energies of the farming class. In the trucking districts there are indications of prosperity on all sides. New settlements, factories for the manufacture of berry boxes, new banks, and dwellings have sprung up within a comparatively few years and there has been substantial progress. The small initial capital required to start in market gardening, the reasonable terms upon which land can be bought near the railroad, the climate, and the wide range of crops to which the soils are adapted offer to the thrifty farmer with restricted means a remarkably good opportunity for success.

A large percentage of the farms in the trucking area are operated by the owners, though the tenant system prevails to a certain extent. The tenants, however, are thrifty and realize a good margin of profit from the year's work. In other parts of the county a much greater proportion of the farms is tenanted, accompanied by the lien system, and where these conditions exist the welfare of the farming class is less marked. The share system of rental is most common, the landowner furnishing the team, implements, and one-half the fertilizers, and the tenant the other half and the labor, an equal division of the net proceeds being made. In the case of berry production, the cost of picking, freightage, and fertilizers is deducted from the total amount realized.

The large estates acquired by the original settlers have generally remained intact, and many farms comprise several thousand acres. On the other hand, especially in the trucking belt, the farms are much smaller, ranging from 10 to 150 acres, and the average for the county at large is about 118 acres. One grower will rarely attempt to handle more than 30 or 40 acres when the land is to be utilized for trucking purposes. Plans for subdividing many of these large tracts into smaller ones and for encouraging immigration are being considered, and much of this land which has heretofore been valued too high or has been offered for public sale in tracts too large to allow the average farmer to purchase will probably be offered on the market in such shape and at such prices as to be available to the small farmer and truck grower. The holding of these tracts is especially noticeable in the vicinity of the small towns along the Atlantic Coast Line Railroad, and has been a serious factor in retarding the development of the county.

Ordinary farm labor grows scarcer with the distance from the railroads, but even in the most populous communities it often is not available. The laborers when paid by the day receive 75 cents to $1, and for longer periods from $10 to $15 a month. As the pay for much of the work of gathering the berry and truck crops is better than can be paid in general farming, the truckers have less difficulty in obtaining help. In the strawberry season the adjoining counties are drawn upon to meet the demand for pickers, and men, women, and children take up a temporary abode in the county. They usually have furnished them transportation to and from the area and are paid at the rate of 1 cent for every quart of berries picked. A good hand can readily fill from 100 to 150 quart baskets a day. As the strawberry season declines the huckleberries begin to ripen, and the hands then direct their attention toward gathering these, which they pick at random throughout the county and sell to buyers, receiving 5 to 10 cents per quart.

Berries and truck, bulbs, tobacco, corn, and cotton are the principal agricultural products of the county. The several varieties of strawberries grown have been originated in this section, and are thus adapted to the climatic and soil conditions. The earliest are shipped by express to northern commission merchants and bring fancy prices, sometimes $8 to $10 a crate, but the price rapidly declines with the advancing season. About May 1 shipments in carload lots in cold storage begin, buyers representing northern and western commission merchants purchasing from producers. The advantage to be gained in having an early crop and in getting it to the platform at the earliest possible date, the keen rivalry between the growers, and the sharp competition among the buyers, all tend to lend a fascination to the industry, and the various platforms at the small towns along the railroad present a scene of unusual activity when the season is in full swing. The average price obtained the season through is about $2 to $2.25 a crate, and the net profit is 50 to 75 cents a crate.

The small town of Magnolia, the center of the bulb industry, has to its credit the largest output of tuberose bulbs of any place in the world, and has maintained this position for the past fifteen years. Ninety per cent of the product finds its way to foreign markets—Holland, France, England, and Germany being the principal purchasers. Caladium, dahlia, canna, and gladiolus bulbs are shipped in large quantities, but few of these are exported. One firm shipped over 1,800,000 bulbs of all kinds during the year 1904.

The greater part of the tobacco crop grown in Duplin County is produced east of the Northeast River. It is of the bright yellow variety and brings an average price of 9 cents a pound. Most of this output is shipped to the factories at Durham, N. C., where it is manufactured into several grades of smoking tobacco.

Irish and sweet potatoes produce well upon most of the soils of the area, but are cultivated chiefly for domestic needs. A few carloads are sent out of the county each season.

Little attention is given to fruit growing aside from the strawberry. A few orchards are scattered here and there throughout the area. The chief difficulty attending the production of tree fruits is said to lie in the unusually heavy precipitation to which the county is subjected, and production would have to be confined to the light sandy soils. The native Scuppernong grape, however, grows prolifically upon most of the soil types, and brings from 75 to 80 cents a bushel at local markets and frequently as much as $1 a bushel at Wilmington, N. C. When better devices for shipping in good condition shall have been found, it is believed a most profitable industry will be developed.

Cantaloupes are grown upon the Norfolk fine sandy loam and Norfolk fine sand and find ready sale in northern markets, bringing good prices. Watermelons are produced to a more limited extent and altogether for local markets.

The timbered lands of the county have long been drawn upon, and at the present rate of cutting it will not be long before the entire area is largely deforested. Valuable tracts of loblolly pine are still to be found in the eastern and northeastern sections of the county, and the numerous swamps, fringing watercourses, and the pocosons support a thick growth of gum and cypress. The several crate factories established in the county depend upon these sources for their raw material.

Stock raising plays no part in the local agriculture except as concerns the individual needs of the farmers. Certain sections are fenced in, and within these the stock is allowed to roam at large.

Transportation by rail is furnished by the Wilmington and Weldon branch of the Atlantic Coast Line Railroad, which traverses the western part of the county in a northwest and southeast direction. Two short lumber roads exist in the county, one leading northwest from Bowdens, and the other terminating near the small village of Resaca. A large part of the produce of the east half of the area is transported down the Northeast River to Wilmington, whence it is conveyed by boat to other markets. Cotton and spirits of turpentine are loaded on flatboats and allowed to drift with the current to their destination. The empty flats are towed back by tugs. One steamer plies between Chinquapin and Wilmington, but, owing to the shallow water at certain seasons of the year, it can only be used a part of the time.

The greatest drawback to the development of a great part of the county is the lack of railroads. Several roads have been proposed and surveyed, but as yet their construction has not been undertaken. The wagon roads of the county are sandy and are kept in a fair state of repair, though they could be much improved by surfacing with the clay which is usually available near at hand.

The cities in the north and west afford markets for all perishable truck, while Norfolk and Wilmington take the cotton for shipment to other localities. The tobacco finds its way to markets within the State, where most, if not all, of it is manufactured. These three classes of products form the money crops of the area.

SOIL SURVEY OF YORK COUNTY, SOUTH CAROLINA.

By J. A. DRAKE and H. L. BELDEN.

LOCATION AND BOUNDARIES OF THE AREA.

York County is one of the northern tier counties and is situated about the middle of the northern boundary of the State. It is irregular in outline, though roughly rectangular. The Catawba River forms about half of its eastern boundary line and Sugar Creek the most of the remainder, while Broad River marks about half of the western border. The dimensions of the county vary from 15¼ to 23¾ miles north and south and from 19½ to 36½ miles east and west, and it comprises 428,416 acres or approximately 669 square miles of territory. Rockhill is the largest and most flourishing town in the county. In 1900 the population of this town was 5,485. Yorkville, the county seat, is situated slightly west of the center of the county. The distances from this point to some of the more important southern inland and seacoast cities are as follows: Atlanta, 247 miles; Birmingham, 414 miles; Richmond, 321 miles; Norfolk, 387 miles; Charleston, 227 miles, and Savannah, 251 miles.

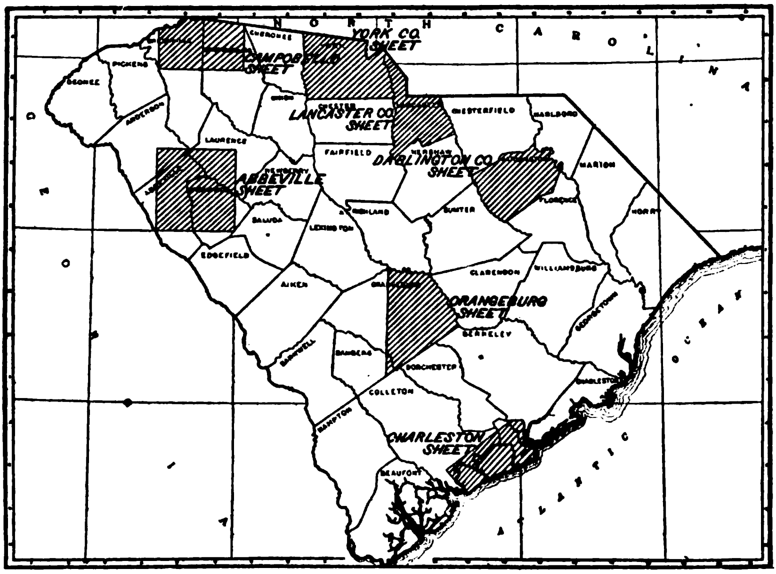

FIG. 11.—Sketch map showing location of the York County area, South Carolina.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The first settlement in York County occurred as early as 1757, the immigrants, who were of Scotch-Irish ancestry, coming principally from Pennsylvania. Upon the organization of the county they called it York after their native county in that State. It is well known that these people were of a most independent and liberty-loving character. When the British began to invade their soil, they banded together hurriedly and helped to deal the crushing defeats on the well-known battle grounds of this and adjoining counties, which are well considered a turning point in the Revolutionary war. This same sturdiness of purpose manifested in civil affairs was from the beginning a great factor in the building up of a prosperous agricultural community and later in making the county what it is at present. In 1790 the population of the county had reached 6,600, 14 per cent of which were negroes.

The earliest product the county had to give to commerce was the fur of wild animals. At that time this part of the State abounded in rich pasture lands, and the "cowpen keepers" soon followed the hunters and trappers. As a result live stock raising soon assumed some importance and large numbers of cattle were annually driven to Charleston and even to Philadelphia and New York. The abundant natural pastures made it necessary to cultivate merely enough land to supply the necessaries of life; but the settlers who tilled the soil increased until their corn and wheat formed a considerable proportion of the county's exports. This grain was floated down the waterways to the seacoast towns. The cultivation of cotton began early in the history of the county, but did not assume much importance until 1840, when 1,733 bales were grown. The cotton was hauled in wagons to Charleston and later to Columbia. About 1850 the Charlotte and Columbia Railroad, now a branch of the Southern Railway system, was constructed, passing through Rockhill. The production of cotton increased at once to 9,000 bales. The extensive production of cotton was confined to the eastern half of the county, which was within easy reach of the railroad. Cattle, sheep, corn, wheat, and oats continued to be of great importance, especially in the western half of the county, although as other railroads were built cotton growing became general in all parts of the county.

A general depression followed the war of 1861. The value of farm land per acre and the value of live stock was only one-half as great in 1870 as ten years before, while there was only two-thirds as much cotton, corn, and wheat produced as then. About this time a stock law was enacted by the different townships, which shows the trend of the agricultural development of the county. Rail timber was becoming scarce and the amount of land under cultivation had increased until it became cheaper to fence in the live stock than the crops, and the law was passed accordingly. This tended, further, to disturb the equilibrium between the number of farm animals kept and the acreage under cultivation, so that in 1880 the output of cotton had increased nearly fourfold. In the next ten years it gradually increased to 32,000 bales. On the other hand, the number of dairy cows had decreased to one-half and that of other cattle and hogs to about one-third of the number in 1850. Since this date cotton has been the chief source of income, for while the combined acreage in corn, oats, wheat, cowpeas, and miscellaneous crops was as great in 1890 as at any earlier time, it was not quite as large as that devoted to cotton. Again, while the population of the county had doubled, there had been no increase in the production of corn, wheat, and oats. Since 1890 more dairy cows have been kept and all classes of stock are of a higher grade.

The manufacture of cotton goods has increased rapidly in the county during the past ten years, until now there are about twelve mills of good capacity in operation. One result of this developing industry has been to increase the size of towns and to better somewhat the local market for farm produce. This has had the effect of improving land values near the towns. The mills, however, have drawn a great many white people from the farms of the surrounding country and agriculture has suffered a retarding influence as well as receiving local stimulus.

CLIMATE.

The climate of York County is mild and equable. The range in temperature, though slightly greater than on the immediate southern coast, is less than for places farther inland. A comparison with the corn belt as represented by Illinois and Indiana shows that while the monthly temperature there for the winter months is 15° to 20° and for the fall months is 7° to 15° colder than for this county, the average for each of the summer months is but 3° to 4.5° cooler. There are occasional freezes, and snow often falls during the winter, but the winter precipitation is mostly in the form of rain. Farm work is often carried on throughout the year.

From the following table, compiled from records of the Weather Bureau stations at Winthrop College and Yorkville, it will be noticed that April and May have less rainfall than the summer months, and also that October, November, and December are the driest months of the year, which greatly facilitates cotton picking and the early winter work of the farm. The rainfall of the area is ample during the growing season for all farm crops.

Normal monthly and annual temperature and precipitation.

Month.	Yorkville.		Winthrop College.		Month.	Yorkville.		Winthrop College.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	*Inches.*	*° F.*	*Inches.*		*° F.*	*Inches.*	*° F.*	*Inches.*
January	43.1	3.86	43.2	3.51	August	77.9	4.96	78.0	4.38
February	46.4	4.77	45.8	4.69	September	73.6	4.38	73.2	4.12
March	53.1	4.90	52.6	4.26	October	62.0	3.78	62.1	3.18
April	61.6	3.78	61.4	3.36	November	53.1	2.98	53.3	2.99
May	71.3	3.58	71.4	3.44	December	46.1	2.98	46.4	2.84
June	77.1	6.75	76.8	4.57	Year	62.0	52.15	62.0	46.56
July	79.2	5.43	79.0	5.22					

The following table gives data regarding the occurrence of frost. The average length of the growing season, as deduced from these records, is about seven months:

Dates of first and last killing frosts.

Year	Yorkville.		Winthrop College.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1897	Mar. 28	Nov. 24		
1898	Apr. 8	Oct. 23		
1899	Apr. 5	Nov. 4		
1900	Apr. 5	Nov. 9	Apr. 5	Nov. 8
1901	Mar. 22	Nov. 6	Mar. 22	Nov. 6
1902	Apr. 9	Nov. 28	Apr. 9	Nov. 28
1903	Mar. 3	Nov. 7	Mar. 2	Oct. 27
1904	Apr. 7	Nov. 17	Mar. 16	Oct. 23
Average	Mar. 30	Nov. 11	Mar. 23	Nov. 6

PHYSIOGRAPHY AND GEOLOGY:

York County is situated in the Piedmont Plateau and has the topographic features common to that province. The surface is a gently rolling plain, becoming more rolling as it approaches the rivers and creeks, and finally hilly and broken on their immediate banks or above the narrow strips of bottom lands through which the numerous water courses flow. That part of the county lying west of the Carolina Northwestern Railroad is cut by more streams and is rougher and more broken than the eastern half, and on this account has a greater area poorly suited to agriculture.

The eastern part of the county is drained by the Catawba River and its principal tributaries, Fishing, Allisons, Crowders, and Sugar creeks. Along most of the course of the river for a mile or more back the land is hilly and broken; but the most of it is in farms, only occasional areas being considered too rough for cultivation. The country adjacent to Allisons, Crowders, and Sugar creeks is rough and broken, which is the character of the surface, though in a less degree, near the smaller branches which flow into them; but this condition does not extend back for such a distance as along the river. The topography is smoother along Fishing Creek, though along the lower 5 miles of its course the slopes are somewhat broken and slightly rough. West and south of this creek there occurs a level tract of country about 22 square miles in extent, which is occupied by the Iredell clay loam, being popularly known as the "black-jack" country. With the exception of this area and the one near Rockhill, in which the same type of soil is found, both of these areas occurring in the form of broad depressions having generally a level surface, the remainder of the eastern part of the county is undulating to rolling and well suited to agriculture in general.

The western part of the county is drained by Broad River and the streams which flow into it. The largest of these are Kings Creek, which enters on the line between York County and Cherokee County, Bullocks Creek, which enters farther south, and Turkey Creek, which does not reach the river within the county. Many creeks and branches unite farther up to form these principal tributaries. The country along Broad River is rougher and the broken zone extends farther back than is generally the case along the Catawba River, and the same character of country is found more uniformly along the creeks just mentioned and their tributaries. Both rivers afford excellent water power, some of which is already utilized. The smaller streams furnish power for running many saw mills and grist mills, for which purpose they have been used since the days of the earliest settlement.

The rocks which, through their decay, have furnished the material for the soils of York County are of igneous and metamorphic origin. They range from coarse-grained and fine-grained granite to rocks of a more basic character, as porphyries and trap, and, among the metamorphics, gneiss and talcose schists. The coarse-grained granites and gneisses have given rise to the Cecil sand and contributed slightly in some cases to the Cecil sandy loam. The predominating rock of the latter type, however, has been a granite or gneiss of finer texture, yet having an abundance of quartz which when liberated remained on the surface to form the sandy loam of the first few inches of the soil. The Cecil clay has been formed from rocks very similar in character, but having in general less quartz and more feldspar. In some cases the finer grained metamorphic rocks have entered largely into the formation of the last-named soil. The more basic rocks, or those having a larger percentage of iron, have formed, by their weathering, the Iredell clay loam. In some instances near this type these rocks have also contributed material to the Cecil clay. The Cecil fine sandy loam and the Cecil silt loam have been derived from fine-grained metamorphic rocks, those entering into the former type differing from those giving rise to the latter mainly in the percentage of fine grains of quartz which they contained, being sufficient in the case of the fine sandy loam to give the coarse texture to the surface soil.

SOILS.

Nine distinct types of soil are shown in the accompanying map. The extent of area occupied by each type appears in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.
Cecil clay	185,152	43.3
Cecil sandy loam	88,768	20.7
Iredell clay loam	40,640	9.5
Cecil silt loam	37,376	8.7
Cecil fine sandy loam	35,136	8.2
Cecil sand	25,216	5.9
Meadow	14,720	3.4
Cecil stony clay	1,280	.3
Rock outcrop	128	.0
Total	428,416	

CECIL CLAY.

The surface soil of the Cecil clay, to a depth of 7 inches, consists of a reddish-brown to red loam or clay loam, which passes abruptly at the depth mentioned into a compact and slightly micaceous red clay, varying little, if any, throughout the remainder of the soil profile to 36 inches. The prevailing character of the surface soil is a reddish-brown or red loam, but over much of the type this more loamy covering has been removed sufficiently to convert the type into a soil of slightly heavier texture or into a clay loam. In small spots on the steeper slopes, where washing has been more severe, the red clay subsoil is exposed, and in such places cultivation is difficult. There is a small area of the type between the series of foothills to Kings mountain and Kings Creek in the extreme northwestern corner of the county, where the soil is deeper and more loamy than is generally the case.

The Cecil clay is a prominent and easily recognized soil of the Piedmont Plateau, and in York County it covers a greater area than any other type. It is not confined to any one part of the area, but is found in large continuous bodies and smaller isolated areas in almost all parts. Its upland position and general undulating and rolling topography affords rapid surface drainage, and unless terracing is practiced there is much damage from washing. Near the rivers and smaller streams the topography becomes rougher and the fields are more broken, in some instances the slopes being too steep for cultivation. In this case, if the best of precautions be not taken, it is often necessary to abandon the fields because of erosion, proving the folly of clearing the timber growth from such slopes. Terracing and contour cultivation is at present practiced throughout the type.

The formation of the Cecil clay has been brought about by the weathering and disintegration of the underlying rocks, which processes have usually taken place to great depths, cuts of 15 feet often revealing only well-formed red clay. Thus little opportunity is offered to study these rocks, but in most cases they are fine-grained granites, gneisses, or schists. West of McConnellsville and in other places where the type adjoins the Iredell clay loam, the more basic rocks of the latter soil have been prominent in its formation.

The agricultural value of the Cecil clay depends more largely on the cultivation and general management it receives than is the case with any of the other soils found in the area. Though naturally a strong and productive soil and one which responds readily to proper treatment and remains productive for a long period of time, shallow plowing, or plowing when wet, insufficient preparation, and neglect in cultivation reduce it below the average and make it one from which only meager results are obtained. It is probable that only in a very few instances are its fullest possibilities realized. "Broadcasting," or breaking up thoroughly with a turning plow, each year to a slightly greater depth, the use of the disk harrow, and the crusher, if necessary, in reducing the surface to a good tilth, followed by frequent but shallow cultivation to prevent the formation of any crust, together with a moderate application of barnyard manure and an occasional crop of cowpeas, may well be considered indispensable for the best results with this soil.

The Cecil clay is best adapted to wheat, oats, and grasses, while the average production of cotton and corn is about equal to that of any of the other types. Cotton makes slow growth in the spring, but after the soil warms up sufficiently and the plants are well started, they will withstand much more wet weather than on the other types. The crop also passes through periods of drought seemingly as well as on types of more favorable texture. Where special attention is given in the way of cultivation and fertilization, a bale and even more of cotton is produced, but the average will run about one-half bale per acre. Twelve bushels of wheat, 20 to 25 bushels of oats, and about 14 bushels of corn are considered fair average yields, while in all cases more can easily be grown. One and one-half to two tons of pea-vine hay have been grown after wheat and oats are harvested, but the general average will probably fall below 1 ton per acre. Though the after effects of growing this crop are not so immediate they are more lasting than on the more sandy types. Aside from the money value of the hay, which is said to be about $10 a ton, the beneficial effects on the soil would warrant an increased acreage in this crop in a regular rotation.

The following table shows the average results of mechanical analyses of the Cecil clay:

Mechanical analyses of Cecil clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
13458, 13460	Soil	2.0	7.8	6.4	18.2	13.2	23.5	28.5
13459, 13461	Subsoil	1.0	4.3	3.5	9.1	5.2	16.2	60.5

CECIL SANDY LOAM.

The soil of the Cecil sandy loam, to a depth of 9 inches, is a very light brown to gray sandy loam, the sand content of which is of the medium to fine grades. The subsoil, from 9 to 36 inches, consists of a compact red clay, essentially the same as the clay material of the Cecil clay, the two types being very closely related.

The topographic features of this soil are not unlike those of the Cecil clay, being of a general rolling character. Occasionally the Cecil sandy loam is found on the upper parts of ridges and the Cecil clay on the slopes below, in more or less broken and disconnected areas, due to the washing away of the sandy loam covering, but in the larger and more important areas, the former type occupies not only the ridges, but extends in its typical form down the entire slopes as well, the only exception being where the slopes are quite steep and deeply eroded. This condition arises near streams and occasionally extends some distance back from their courses. In such areas the subsoil frequently becomes less typical, changing to a more yellow color and to a looser and more open texture. Throughout the areas of this soil it is necessary to employ terraces or sidehill ditches to prevent erosion.

The important areas of this soil occur southeast and west of Fort Mill, north and northeast of Lesslie, about 5 miles south of Rockhill, south and east and northeast of Yorkville, while smaller and less important areas are found here and there in nearly all parts of the county. Other areas too small to be shown on the accompanying soil map, which is drawn on the scale of 1 inch to the mile, occur in slight depressions within the different areas of the Cecil clay wherever the sand has accumulated to a sufficient depth. The same is true of small areas of Cecil clay within the areas of Cecil sandy loam, where the surface sandy loam has been removed by washing, exposing the red clay below. In a few instances this mixture of the types occurred in so nearly equal proportions that it was a question for somewhat arbitrary decision which to indicate on the map. These bare spots require the same careful treatment as the Cecil clay, while the more sandy areas possess the peculiarities of the Cecil sandy loam, and hence are no little trouble in the cultivation of some fields.

A small area in the extreme southwestern part of the county along the Chester County line and extending to Broad River differs to some extent in both soil and subsoil from the main bodies of the type. Here the soil from 8 to 10 inches is a heavy dark-brown to reddish-brown sandy loam, containing a considerable proportion of coarse to medium sand, and the subsoil to a depth of 36 inches ranges from a sticky sandy loam to a heavy loam or sandy clay of a red color. Large yields of corn are secured on this phase, which is also well adapted to cotton, wheat, vegetables, and fruits.

The Cecil sandy loam is residual in origin, being derived from the underlying igneous and metamorphic rocks, principally granites and gneisses, in which a larger percentage of quartz is present than in those which form the larger and more typical areas of the Cecil clay. The finer clay particles have been removed by the drainage waters, and a larger proportion of the quartz particles has been left on the surface, forming the sandy loam covering. A small quantity of sand is likewise present in the subsoil, and quartz fragments of varying sizes are found in both soil and subsoil and on the surface, though only in a few instances in sufficient quantities to be a hindrance to cultivation.

While in productiveness the Cecil sandy loam is about equal to the Cecil clay, it possesses some salient differences. It is easier to cultivate, no special care need be taken as to the time or condition of the field when plowed or cultivated to prevent the formation of a crust or clods, and a cultivation is not so essential after rains to prevent the escape of moisture. While it warms earlier in the spring and is a more typical cotton soil in this one respect, in the event of too frequent and prolonged rains cotton is greatly injured. The practice of producing one crop continuously for many years has greatly exhausted the supply of organic matter, and its productiveness would quite generally be improved by increasing this very essential constituent. On the whole, however, it is a very desirable soil, well suited to the agricultural practices of the area.

Cotton, corn, pea-vine hay, and sorghum forage are grown with about equal success, but the soil is probably best adapted to cotton. By returning the seed from the crop each year and applying small quantities of commercial fertilizers, no difficulty is experienced in producing good yields year after year continuously, but such a system of cropping is not to be recommended. Under the present conditions one-half bale of cotton is an average yield. Experience has demonstrated that with the use of stable or cowpen manures and the growth of an occasional crop of cowpeas this yield can be almost doubled, with less expense for mineral fertilizers than under the present system. Such a system is equally as important with all the other crops grown. About 12 bushels of corn, 18 to 20 bushels of oats, 10 bushels of wheat, and three-fourths to 1 ton of pea-vine hay are fair average yields per acre under the present average conditions of the type, all of which yields could be easily made much greater in the simple way suggested for cotton. Wheat and oats are not grown now as much as formerly on the type, but followed by cowpeas, both of these grains, although not so well adapted to this soil as to the Cecil clay, can be made profitable crops. The growing of cowpeas is increasing, and the beneficial effects upon the soil are very noticeable. This practice, together with slightly deeper plowing, so as to mix a part of the subsoil with the sandy top soil, can be relied upon to bring about a very great improvement in the productiveness of this type, even though it may in general be considered in a comparatively fair condition now.

The following table gives the average results of mechanical analyses of this type of soil:

Mechanical analyses of Cecil sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
13470, 13474	Soil	6.3	18.1	9.3	25.8	13.0	14.9	12.2
13471, 13475	Subsoil	3.5	7.2	3.8	7.3	3.8	23.8	51.2

In order to ascertain the manurial requirements of this soil, an examination was made by the wire-basket method. For this purpose a sample was selected from a field 2 miles northeast of Rockhill. This field has been planted to cotton continuously for thirty years, receiving applications of cotton-seed meal, acid phosphate, and manure in the last few years.

The results obtained indicate that a decided increase in productiveness may be obtained by the use of a complete fertilizer with lime, by the use of manure, or of cowpeas and lime. Fair results were obtained with nitrate of soda and sulphate of potash, with acid phosphate alone, with lime alone, or nitrate of soda alone. It was also found that lime when added to the soil several weeks before the soil was planted gave much better results than when added immediately before.

In these tests wheat plants were used as an indicator, and while the results are not held to be strictly applicable to other and unrelated crops, they will no doubt be found to be applicable to a large part of this soil in the area.

CECIL SAND.

The surface soil of the Cecil sand consists of a very light gray to white sand or sandy loam, medium to coarse in texture, and varying from 8 to 18 inches in depth, with an average depth of about 14 inches. Where the fields are newly cleared the soil has a decidedly darker color and the first 4 inches is a loamy sand, which condition is due to the presence of a comparatively large proportion of organic matter. This, however, disappears after several years of continuous cropping, and the soil assumes the light color so characteristic of the type in general. While this supply of humus lasts the soil is much less affected by extremes of temperature and moisture content and possesses a greater crop value. Almost all of the type has been under cultivation for a great many years, in many instances cotton being the only crop for from twenty to thirty years in succession, and in the present condition of the soil moisture soon evaporates from the surface and crops are apt to suffer during slightly prolonged droughts, while frequent and prolonged rains are equally as injurious. Light showers at frequent intervals furnish the most ideal conditions for plant growth on this type.

The subsoil grades at varying depths from the overlying sand into a yellow sandy clay, open and somewhat porous in the upper part, but becoming more compact and having a higher clay content at the depth of 36 inches. Some coarse sand and fine gravel are generally present throughout the profile.

The Cecil sand is found in widely separate parts of the county, mainly in three continuous areas of from 8 to 12 square miles each. The largest and most level of these tracts extends 3 miles east from Clover and north to the county line. Another occurs northwest of Yorkville and west of Filbert. The third is in the southeastern part of the county and constitutes the region locally known as "Sand Tuck." Two smaller areas occur just east of this one near Catawba Junction, and others of similar size are found in different parts of the county.

The Cecil sand generally has a rolling topography. It occupies broad, well-defined divides which are cut here and there by small streams and erosions. Near these are the most rolling parts of the type, but only in a few instances is the surface rough. Farther from the streams the surface gradually becomes less rolling and in many instances is merely undulating. The general surface configuration, together with the relatively high position, affords excellent drainage and allows the fields to dry off quickly.

The Cecil sand is formed by the weathering and decomposition of a coarse-grained granite. During this process the finer particles of the surface soil have been removed by the drainage waters, while the coarser material, which is abundant in this rock, has been left on or near the surface.

The general characteristics of the Cecil sand adapts it naturally to the production of early truck. Each of the principal areas are found near railroads, but as yet no attempt has been made to grow truck crops for the market, possibly on account of the relatively high freight rates. Melons are now grown to some extent for the local markets and the result, so far as the product is concerned, is very gratifying. Cowpeas do well and show marked beneficial effects in the next succeeding crop. Farmers should sow this crop as often as possible and try to make it a part of a regular three-year rotation, suggested elsewhere in this report. The decay of the roots, besides furnishing nitrogen, also supplies organic matter and in a measure corrects the one great deficiency in this type of soil. Where this is done, much better results with all crops may well be expected, especially if manure is also applied.

Cotton is the chief crop grown, and corn, wheat, and oats to a much less extent. Sweet potatoes of an excellent quality are produced, but for domestic use only. Eight bushels of wheat, 18 bushels of oats, 10 bushels of corn, and one-half bale of cotton are fair average yields. The fact that this type is easily worked adds much to its favor in the estimation of the farmer, and this together with the fact that by fertilizing thoroughly it produces a yield of cotton equal to most of the other soils of the area, causes it to be valued at about the same price, which usually ranges from $6 to $10 an acre.

The following table shows the average results of mechanical analyses of the Cecil sand:

Mechanical analyses of Cecil sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
13466, 13468	Soil	8.5	14.8	12.6	31.2	13.4	14.0	6.0
13467, 13469	Subsoil	4.9	7.2	5.0	11.8	5.6	13.9	51.0

In order to study the manurial requirements of this soil, a sample was collected and examination made by the wire-basket method. The field from which the sample was taken is located about 2 miles southwest of Lesslie. It has produced crops of cotton, corn, oats, and cowpeas, but has received very little fertilizer, and is below the average in productiveness.

The results obtained show that a marked increase in productiveness may be obtained by heavy applications of stable manure, the use of a complete fertilizer, with or without lime, or by the use of cowpeas and lime. Sulphate of potash with acid phosphate, and nitrate of soda alone or with sulphate of potash produced a small increase. Lime when used alone gave only a very small increase, but when used in connection with other fertilizers seemed to be very beneficial.

In these tests wheat plants were used as an indicator and the results are not held to be applicable to other and unrelated crops or to fields which have received treatments essentially different from that from which the sample was taken.

IREDELL CLAY LOAM.

The Iredell clay loam is locally known as the "Black-jack" lands, so named from the predominating tree growth. The surface soil, averaging about 8 inches in depth, is a dark-brown loam which contains a large amount of organic matter as compared with the other soils of the county. There is usually a large percentage of small, gravelly iron concretions present in the soil and on the surface. Toward the outer edge of most of the different areas of the type the soil becomes sandy, on account of the influence of the surrounding types. The subsoil differs widely from the soil both in texture and color. From 8 to 30 inches it is a stiff, tenacious, waxy clay of a light-yellow color, and practically impermeable, locally known as "pipe clay." The subsoil is very retentive of moisture, and when only moderately wet plowing deeper than the shallow top soil is impracticable. Deeper plowing can be practiced, however, when the material is in a slightly drier condition by the use of the disk plow. The impervious clay stratum prevents disintegration and decay taking place at any great depth, as is the case in the Cecil clay and other types, and, as a result, below 30 inches there is usually found only partially decomposed rock material, which is looser and more open in texture than the superimposed material.

The largest area of the Iredell clay loam, and the one best suited to agriculture, is situated in the southern part of the county, extending east and west from Smiths Turnout and thence northward beyond Fishing Creek. This area occupies a broad basin-like depression, surrounded on all sides, except the south, by higher elevations. The soil is quite dark in color, the surface is level to gently undulating, and in many instances the natural drainage is very poor, but in almost every instance this can be overcome by surface ditching. As yet land values have not justified the expenditure of money in testing tile drainage, but when values increase the experiment should be made.

The area of next importance in size occurs south and southeast of Rockhill, beginning at the edge of the town and extending about 4 miles in an unbroken tract. Much of the surface soil of this area is somewhat lighter in color than in the area just described, the difference being due to the lower content of organic matter. This area also occupies a broad depression, but has a topography slightly more rolling and in general is better drained. Near Rockhill the type is somewhat stony and uncleared, being ill-adapted to cultivation. Stony areas occur in other parts of this body, but are of less extent. In many instances the stones have been picked from the surface and fields have thus been rendered well suited to cultivation even where they were practically worthless before.

An area about 4 square miles in extent occurs northeast of Rockhill, the most of which lies at a somewhat higher elevation, is more rolling, and has better drainage than the two areas already referred to. A slightly stony condition is quite prevalent, but in most cases the quantities are not sufficient to prevent cultivation. Smaller areas are found north of Fort Mill near the State line. About 8 square miles of the type is located in the southwestern part of the county, much of which is also stony. The topography is rolling, and while much of the area is under cultivation, a large proportion of it is better suited to grazing.

The Iredell clay loam is residual in origin, being derived from the weathering and decomposition of basic, igneous rock, which occurs in the form of intrusive dikes. The process of formation is practically the same as that of the other principal types of the county, but the difference in the character of the parent rock has formed a soil of striking peculiarities. The presence of an excessive amount of iron in this rock is doubtless largely responsible for the sticky, waxy nature of the subsoil.

It is said that the best of the Iredell clay loam was formerly considered almost worthless for anything but growing corn or grazing and that as late as fifteen years ago it could be bought for 50 cents an acre. Corn and grass could be grown to a good advantage, but other crops, especially cotton, rusted or "frenched" and gave very poor yields. This has been overcome, it is stated, by the use of potash fertilizers, principally kainit, and at present the type is considered a cotton soil about equal in productiveness to any other type in the county, although it must be admitted that all crops are greatly injured during wet years. About one-half bale would probably be the average production of cotton, though a bale per acre is often produced. This crop is now by far the most important of any on the type, and the acreage is believed to be increasing. As compared with the other soils of the county it is also well adapted to small grains and grasses. Yields of 12 bushels of wheat and 25 to 30 bushels of oats are often secured. Bermuda grass thrives, yielding an abundance of pasturage and hay. Cowpeas and sorghum do well, producing about a ton of forage per acre and occasionally more. Ten to 12 bushels of corn is considered a good yield. A small field was sowed to alfalfa last year, the success of which remains to be seen. So far it seems to be doing well, and it is probable that with proper preparation of the soil this crop may be grown with a reasonable degree of success on the better drained portions of the type. If reasonably successful, it would prove a great benefit to the impervious subsoil. It is more reasonable to suppose, however, while it may do well enough to be profitably grown, that this waxy, close-textured subsoil will in general be prohibitive, as this crop does best on a deep soil with a loose open subsoil, well-drained bottom lands, which are seldom or never overflowed, being probably the ideal situation for the crop in the east.

There are a number of relatively small areas along or near Turkey and Bullocks creeks and their branches which have been classified as the Iredell clay loam, although differing in some respects from the general description of the type. Here the soil to an average depth of about 6 inches is a light-gray sandy loam, the sand ranging from medium to fine in texture, but the subsoil is very similar to that in the main areas of the type. This phase is not so well suited to agriculture, the topography being characterized by deep erosions, steep slopes, and narrow ridges. Some cotton and corn are grown, but the yields are small.

The following table shows the average results of mechanical analyses of the Iredell clay loam:

Mechanical analyses of Iredell clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
12824, 13488	Soil	10.4	14.9	5.6	12.6	10.6	27.6	18.2
12825, 13489	Subsoil	1.4	3.8	1.7	8.9	8.0	34.6	46.8

The manurial requirements of this soil were determined in tests made by the wire-basket method. For this purpose a sample was collected near Ogden. The field from which the sample was taken has been in cultivation eighteen years, and for the past ten years has been in cotton, with a gradual increase in yield, due probably to thorough cultivaiton and the use of considerable quantities of manure, ashes, and kainit.

The results obtained by this examination indicate that a large increase in productiveness can be secured by the use of manure. Nitrate of soda, cowpeas and lime, or a complete fertilizer gave a small increase, while sulphate of potash alone, lime alone, or acid phosphate alone gave little, if any, benefit.

In these tests wheat plants were used as an indicator, and the results are not held to be applicable to other and unrelated crops or to fields which have received treatments differing from that of the field from which the sample was taken.

CECIL SILT LOAM.

The Cecil silt loam is a light-gray to white silt loam, with an average depth of about 8 inches. The type has the local names, "white land" and "gray land." The light color, which is doubtless due to low organic matter content, is prevalent throughout the type, except in occasional slight depressions or on slopes where the subsoil comes near the surface. This latter condition often gives rise to a rather heavy silt loam surface soil. The subsoil, extending from 8 to 36 inches, is a light-red to reddish-yellow heavy silt loam or sometimes a red clay. In general, the type is comparatively free from large stones, but areas are of frequent occurrence where from 5 to 25 per cent of the true soil and a smaller proportion of the subsoil is composed of angular quartz fragments.

The type was first encountered in the extreme eastern part of the county, where an area of considerable extent occurs north of Catawba Junction, along the Catawba River. No other body of this soil was found until the survey had reached the western and northwestern parts of the county where it becomes the principal type. It extends along the North Carolina line for a distance of about 6 miles and extends southwest to the Cherokee County line and to the vicinity of Smyrna and Hickory and westward to Broad River. The northern part of this extensive tract is quite generally rough, uncleared, and very little under cultivation; but this condition decreases to the south. The type as a whole is rolling to rough, the streams and draws having reached considerable depths below the adjacent slopes and ridges. The roughest parts are found near the rivers and small streams and where the type approaches the foothills of Kings Mountain. The general surface is such as to afford excellent surface drainage, but on the steeper slopes it is so rapid and the soil washes so readily that where cultivated great care must be observed to prevent serious damage by erosion.

The Cecil silt loam is formed by the weathering of highly metamorphosed schistose rocks. It is generally considered a rather poor soil for agricultural purposes. The possibilities of improving the fields which are best suited to cultivation, however, are very great. The lack of organic matter is doubtless the main deficiency of the type, and the chief aim of the farmer should be to remedy this defect. Possibly no means of accomplishing this is more easily within the reach of all than the growing of field peas at frequent intervals, preferably in a regular rotation. The beneficial effect of stable and cowpen manure on this soil would, it is believed, be found to be very great. All the roughage, grass, and stubble which accumulates on the farm should be plowed under to a good depth.

Cotton is the prevailing crop on this soil, as on the other types of the county. The yield is probably lower on an average, doubtless dropping below one-half bale per acre. Corn is grown to a less extent and the yield is correspondingly low, 6 to 10 bushels per acre being considered a fair yield under ordinary conditions. There is very little wheat and oats grown. Most of the farms have an ill-kept appearance. The price of land varies from $5 an acre for the poorer to $12 an acre for the better areas.

The following table shows the results of the mechanical analysis of a typical sample of the soil and subsoil of the Cecil silt loam:

Mechanical analyses of Cecil silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
12822	Soil	1.5	3.7	1.3	4.2	12.9	61.4	14.7
12823	Subsoil	0.9	1.7	.7	2.5	6.9	43.3	43.6

CECIL FINE SANDY LOAM.

The surface soil of the Cecil fine sandy loam is a gray to light-gray fine sandy loam, averaging about 8 inches in depth. Below this is found a light-red to yellow silty clay. This soil as a whole is very closely associated with the Cecil silt loam and may be considered an intermediate type between it and the Cecil sandy loam. In some instances it grades so gradually into the silt loam that it is difficult to determine the exact boundaries. Like the silt loam, also, small quartz fragments are frequently scattered over the surface.

About 35,136 acres of this soil was mapped, occurring in two principal and a few smaller areas. The largest one of these areas, situated in the northwestern part of the county, extends from the State line in a southwest direction to within a few miles northeast of Hickory. One of less importance begins about a half mile west of Hickory and continues westward almost to Broad River. A still smaller area is found southwest of Smyrna, which, together with a few others of less extent, constitutes the remainder of the type in the western part of the area. A continuous area, containing 14 square miles, is situated in the southeastern part of the county, in the vicinity of Lesslie and Catawba Junction. It will be noticed that the areas of this type occur quite generally between the Cecil silt loam and the other soil types.

A generally rolling topography, accompanied by good surface drainage, is found in this type. Terracing to prevent erosion is necessary and is practiced over most of its extent.

The Cecil fine sandy loam is derived from the underlying rock formations, which range from a fine-grained granite to the finer-textured crystalline rocks found beneath the Cecil silt loam, enough of the finer quartz particles being present to form a sandy loam.

The crops grown on this soil do not differ materially from those on the others. It is probably a slightly better type than the Cecil silt loam, but is generally rather inferior to the Cecil sandy loam, as indicated by the crop yields. A greater proportion of the type is under cultivation in the southeastern part of the county than in the northwestern and the farms are better kept, showing a more prosperous condition and a more advanced agriculture.

The following table gives the average results of mechanical analyses of the Cecil fine sandy loam:

Mechanical analyses of Cecil fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
13478, 13480	Soil	0.8	2.7	3.0	28.8	36.9	17.1	11.6
13479, 13481	Subsoil	.4	2.1	2.0	12.3	18.9	13.9	49.7

MEADOW.

The Meadow is usually a loose loamy sand to sandy loam. It lies along the streams and is commonly known as bottom lands. In this area the Meadow forms some of the best corn lands. Some of the type is low and wet, a condition probably more prevalent along the smaller streams, although not constant along the entire length of any of them. The Meadow along the rivers would normally be overflowed only in the case of floods, were it not for artificial dams. Above the dam of the Catawba Power Company on the Catawba River all of the Meadow is under water most of the time, while below this dam some excellent farming land exists, the greater part of which is under cultivation every year, and little damage from overflow is sustained.

Corn is the principal crop, yielding from 40 to 50 bushels during favorable years and averaging probably 20 bushels one season with another. Abundant growths of hay and grass are produced, and occasionally good yields of cotton. About the same condition exists along the Broad River, but the bottoms are usually narrow. Alfalfa could probably be successfully grown on the higher and better drained areas, where not subject to overflow.

CECIL STONY CLAY.

The Cecil stony clay is a heavy red loam, 6 to 8 inches deep, underlain by a heavy red clay to the depth of 36 inches. On the surface and within the soil is usually from 30 to 60 per cent of rock fragments, from 6 inches or less in diameter to small bowlders, and the subsoil generally contains a smaller percentage of a rock of very similar character.

There are thirteen small areas scattered over the county, no one of which is much over one-half square mile in extent. The most typical development is found in the areas near Turkey Creek, in the southwestern part of the county, and on Nannys Mountain and two other hills near it in the northeastern portion. On Henrys Knob, west of Clover, and on a narrow ridge of Kings Mountain in the extreme northwestern corner the rocks are metamorphic instead of granitic, and the soil is more silty in character. The type here, as well as on Nannys Mountain, is too steep and rough to admit of cultivation—

in fact, it is not even suited to pasture, its principal value being for forestry purposes. Very little of the type is under cultivation, almost its entire area being devoted to pasture or allowed to remain in forest.

The following table gives the results of mechanical analyses of fine earth samples of the Cecil stony clay:

Mechanical analyses of Cecil stony clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
13484	Soil	0.5	1.6	2.3	22.7	12.9	18.0	41.8
13485	Subsoil	1.3	3.6	4.2	22.1	14.3	18.8	35.4

ROCK OUTCROP.

The two small areas of Rock outcrop in the county occur east of Clover. Here the coarse-grained granite that forms the Cecil sand of that part of the county is laid bare. On the Cecil sand northwest of Yorkville large and isolated bowlders occur, but not to such an extent as to warrant classifying the areas as Rock outcrop.

AGRICULTURAL METHODS.

The benefit of better preparation and cultivation of the soil is being realized in this part of South Carolina, and modern farm machinery is coming into use with good results. There is, however, here as elsewhere, the same conservatism and tendency to stick to methods which have been in vogue so long as to become second nature, which is characteristic of the man who tills the soil. These methods combine what would seem to be the experience of farmers for a long period of time, but many of them have been formed without much thought or experimenting to test their real value. There is, therefore, much room for improvement in the general agricultural practices of the county.

The tendency to grow the crop which can be most easily turned into ready money at the close of each season has caused the attention of all to be turned principally to the production of cotton. In this way a one-crop system has become the dominant feature of the local agriculture. There is always a ready market for this product, and considering only the matter of immediate income the farmer can not see how he can afford a change of crop for even a year for the benefit of the soil, and consequently keeps on growing cotton year after year on the same fields sometimes for as long a period as twenty to thirty years. In this way the organic or humus content of the soil is exhausted, especially on the more sandy types, and the natural productiveness is reduced, and the crop must be kept up by the use of commercial fertilizer and cotton seed. By fairly liberal applications the yields are maintained reasonably well, and no very serious effects are noticed, but it is believed this is done at too great a cost. In 1900 there was an expenditure of $113,000 for fertilizers. A matter now almost totally neglected—the production and proper use of manures on the farm—would change this aspect of the case. It is the belief of some of the best farmers that with the use of stable or other manures more cotton can be grown per acre than under the present system. It is probable, however, that the best results can be obtained by a combination of organic and mineral fertilizers. There is, therefore, in any event an imperative demand for the keeping of more live stock on the cotton farms.

Another very important matter in growing cotton is a more careful selection and consequent improvement of the seed.[a] This is receiving very little attention, the seed for planting being taken in bulk as it comes from the gin. Much can be done to increase the yield by selecting seed from the best and most thrifty plants, which possess ideal qualities in regard to stock or weed, number of bolls, and length and quality of staple. These seed should be planted on a separate plot, away from the remainder of the crop, and the plants given special attention. Some provision of this kind should be made each year for getting the best seed possible for the next season's planting.

The preparation of the soil for the crop should in general be more thorough, and the plowing, especially on the clay and "black jack" lands, should be deepened as much as possible. Fall plowing, it is thought, is a good practice. More level cultivation would also doubtless prove an advantage.

By establishing Bermuda grass pastures and growing more forage of different kinds, including the legumes wherever practicable, cattle and cotton raising should go well together. It is said, however, that this can not be done profitably; that the expense of feeding an animal through the winter is often equal to his value. The introduction of better meat-producing strains, or, where local conditions would permit, of dairy cattle, would perhaps show the question in a different light, and even if this is not done the farmer should consider that his feed has partly been converted into a form which is of most value to him on his farm and that he should look for the real profits in the increase in the next year's cotton crop and the general improvement of his land. It is time to cease working for immediate returns in money to the detriment of the soil.

There is also great need of a systematic rotation of crops, but because few crops will yield as much in ready money as cotton this feature of a rational agriculture is not considered. Here the increase in the number of farm animals will play an important part, making possible rotations that would not be profitable otherwise, since the production of more forage becomes a necessity. An excellent yet simple rotation well suited to present conditions is, first year, cotton; second year, corn and cowpeas; third year, wheat or oats, followed by a crop of sorghum and cowpeas or cowpeas alone. If desired, the wheat or oats may be omitted and two crops of pea-vine hay grown, cotton following the next year. In regard to oats, it is quite generally believed that this is not a profitable crop to grow, but by sowing in September, either by the open-furrow system or with a drill, a yield of as much as 50 bushels has frequently been secured. Many prefer sowing in the open furrow, as it aids the crop in withstanding the effects of the freezing and thawing of the soil during winter. Spring oats should not be sown. In this rotation experience might show that it would be preferable to apply to the peas whatever manure was derived from the feeding of stock. Frequent mention has already been made in this report of the value of growing cowpeas, preferably in some such rotation as detailed above, but considering the success with which this crop can be grown and the beneficial effects that result it is thought that too much stress can not be placed on this subject, and it is gratifying to note that there is from year to year a gradual increase in the acreage devoted to this crop.

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[a] For an interesting discussion of the selection of cotton seed see Improvement of Cotton by Seed Selection, by Herbert J. Webber, Yearbook Dept. of Agr., 1902.

To overcome certain market conditions and to regulate the price of the raw material somewhat, there is a general movement in the cotton-growing States to reduce the acreage. This is probably a very wise precaution against low prices in general, but while the farmer is reducing his acreage there should be a determined effort to increase the production per acre by the use of improved seed, better cultivation, and by building up the worn-out fields. At the same time the land withdrawn from cotton culture should be devoted to some other product giving direct or indirect profit. This is another argument in favor of rotation.

AGRICULTURAL CONDITIONS.

That a general betterment in the condition of the land-owning class of the agricultural population has been taking place is very evident. While the degree of prosperity varies somewhat in different sections of the county, because of differences in local conditions, soils, etc., by far the greater part of the county is well suited to development of agricultural interests, and the general progress made not only equals but surpasses that of most cotton-growing districts. A large proportion of the farmhouses are commodious, well-built two-story buildings, painted and in good repair. Many are new structures and many others are in the course of construction.

In those parts of the county in which these signs of prosperity are the most marked the land holdings are generally smaller than the average and under the direct management of the owner who lives on the land himself. Where it is possible to secure sufficient and reliable labor by the day or month probably the most satisfactory results are obtained in this way, but this is becoming more difficult from year to year. The next most satisfactory way, if not equally satisfactory, is to rent the land in "one-horse farms," about 30 acres each, the owner of the land furnishing the mule to tend the crop, having general supervision as to the acreage to be planted to each crop, change of crops, cultivation, etc., and receiving a part of the crops as payment. Under this system, also, the landowner enjoys the right to see that the farm animals are well cared for and kept in good condition. One-half of the entire crop is the rent usully charged. A number of landowners live in town, often some distance from the farm, and lease it by the year for a cash rental, usually about $1 to $1.25 an acre, but as a rule, even where land is leased, payment is made in cotton, from 800 to 1,000 pounds of lint cotton for each one-horse farm of about 35 to 40 acres. In this case the tenant furnishes the work stock and generally all fertilizers. While the rent is nearly always paid, little interest is taken by the tenant to keep the farm productive. In nearly all cases and under whatever system it is necessary for the landowner to "advance" the tenant sufficient provisions for himself and family during the winter and until another crop is produced, which crop in turn is mortgaged and practically consumed before it is ready to gather. The fact that only 25 per cent of the total number of farms in the county are operated by the owners shows how prevalent these practices are.

In 1900 the average size farm in York County contained, according to the census, 84 acres. As a matter of fact the individual holdings are much larger than this, as the classification used by the Census Office in 1900 rated each tenancy as a farm.

Formerly there was adequate supply of farm labor, but changed conditions have gradually been bringing about a scarcity, the effects of which, although varying somewhat in different sections, are being felt more or less all over the country. The increase in the cotton manufacturing industry has taken practically all the white laborers to work in the mills. Since over 52 per cent of the population of the county are colored, it would seem that all needed farm labor could be drawn from this race, but many seek other employment, generally in the towns or on public works where the wages are higher, while the more skilled agriculturally prefer to farm for themselves under one or another form of tenancy. As a result a general scarcity of labor is being felt, which will in time have its effect upon the agriculture of the area. The farmer will have to meet this by doing his own work with the aid of more improved machinery. It is not an uncommon sight now to see the white farmer and his entire family at work in the fields together during the busiest season of the year.

The importance of cotton as a product of the county may be appreciated from the fact that it lacks but little of covering as large an acreage as all the other crops combined. It is the one crop of the county, and the prosperity of almost the entire producing population depends directly or indirectly on the amount of money this crop brings into the county at the end of each season. Corn is the crop of next importance and in 1900 was occupying almost two-thirds as large an acreage as cotton. It is found that early planting yields the best returns. According to the same authority wheat was the crop of next importance, but there has been a general decline in the acreage since 1900. Other crops have comparatively small acreages, and, like corn, are grown only in sufficient quantities to meet or partially meet local requirements.

Formerly little or no attention was given to the growing of grasses, legumes, and other forage crops. The area of land devoted to these crops shows a decided increase in recent years. It is said that alfalfa can be easily grown in the county, though this legume has not been given a general test on the different soils to determine the yields and the length of time the fields will run without reseeding. Bermuda is considered the best grass for pasture and hay, and it stands drought better and gives more constant yields than any of the other sorts tried. Japan clover makes excellent pasturage. Several crops of good hay are often cut when the season is favorable. It is a very common complaint that red clover is not well suited to the conditions of the area and that it does not stand the heat of summer well. But this crop under favorable treatment in the way of a thorough preparation of the soil and a moderate application of manure was observed to give quite satisfactory results on several fields in the county, and it is believed that it can be very profitalby grown if these precautions are taken. Crimson clover is probably better suited to this clmate, but on the whole is probably not so desirable a crop as red clover. There is little market for clover hay, and since there are comparatively few cattle in the county there is little to encourage the growth of either of these crops as a source of direct profit. Johnson grass grows to a good advantage, especially in the bottom lands, where it is quite common, yielding a large quantity of hay and good pasturage. It is difficult to kill out and is a great hindrance to cultivation, which with its tendency to spread makes it very objectionable. Sorghum thrives, gives large yields of forage, and is meeting with general favor throughout the county. The production of dairy products is limited to supplying the local markets.

Because of the one-crop system of the area there is little opportunity to take advantage of soil adaptation, and no attention is paid to the matter. There are differences, nevertheless, which are plainly recognizable. The Cecil clay is well adapted to the growing of wheat, oats, clover, and cowpeas, and the grasses, while it is a very strong soil for cotton and corn, the average yields of the former probably equaling that on any other type in the county. The objection sometimes offered is that the lint is often stained by the red dust or the splashing of the soil by beating rains. This soil is easily built up, and it keeps cotton producing later in the fall than do the other soils. The Cecil sandy loam is more typically a cotton soil, but fair yields of corn, wheat, and oats are also obtained. Sweet potatoes and other crops which require a warm soil do well. The subsoil is not open or porous, and hence holds moisture well, and the soil is sandy and easily cultivated, and on the whole it is a type which comes nearest meeting the general requirements of all the crops of the area. The Cecil sand is best suited to cotton, melons, and early truck crops, and the Iredell clay loam to grass, cotton, and corn. The Meadow, or bottom lands, of the area is best adapted to corn and to grasses for hay and pasture. Where well drained and not subject to frequent overflow, alfalfa would perhaps do better on this than on any of the other types of the area.

The transportation facilities of York County are above the average for the Southern States. One branch of the Southern Railway crosses the eastern part through Fort Mill and Rockhill. Another branch crosses from the southeast corner and passes out near the northwest corner, running through Rockhill and Yorkville. The Carolina and Northwestern passes north and south through the center of the county, touching McConnellsville, Yorkville, and Clover. The Seaboard Air Line passes through the extreme southeastern part of the county. These roads afford a great number of shipping points, which are well distributed and within reach of nearly every part of the county.

Several first-class macadamized roads have been built during the last few years and more are under construction. Aside from these the roads of the county are poor during much of the winter and spring. There are a few modern road scrapers in the county, and by a more extended use of these the dirt roads in general could be greatly improved.

The present markets of York County are limited mainly to the handling of cotton. The production of all the other agricultural products now grown, or which might be grown, depends simply on the local demand or the demand of the near-by larger Southern cities. While there is probably sale for more fat cattle, sheep, and hogs than are now produced, the facilities for handling these locally are wanting and do not permit of any great increase along these lines. The establishing of a first-class packing house within the borders of South Carolina, insuring a certain and constant market for live stock, would do much to encourage the live-stock industry, so badly needed to work improvement in the present system of agriculture. This matter is believed to be worthy the attention of local capitalists.

SOIL SURVEY OF CHEROKEE COUNTY, SOUTH CAROLINA.

By J. A. DRAKE and H. L. BELDEN.[a]

LOCATION AND BOUNDARIES OF THE AREA.

Cherokee County lies in the northwestern part of the State of South Carolina and adjacent to the North Carolina line. It is bounded on the east by York County, on the south by Union County, and on the west by Spartanburg County. Broad River, after flowing across the county, forms a part of its eastern boundary, and Pacolet River its southern boundary.

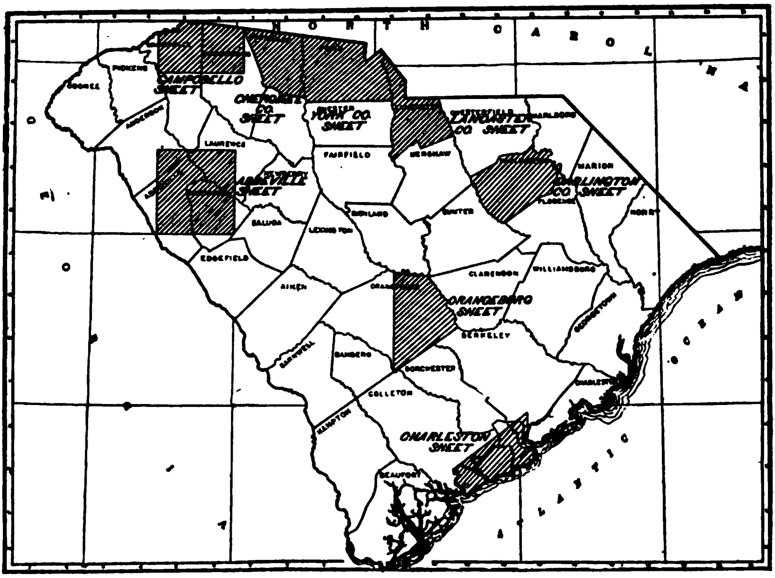

FIG. 12.—Sketch map showing location of the Cherokee County area, South Carolina.

Gaffney, the county seat, is a thriving, progressive town, which has gained rapidly in population and commercial importance within the last ten years. Its present population is not less than 4,000. Blacksburg is another town of considerable importance in the county.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

In 1897 Cherokee County was formed from portions of the three adjoining counties—Spartanburg, Union, and York. The early settlers came from Pennsylvania, Virginia, and North Carolina, and were mostly of Scotch-Irish and English ancestry. They began locating permanently within the present boundaries of this county between 1760 and 1770, and, being a considerable distance from the towns that sprang up in each of the counties above named, this section remained comparatively thinly populated until a hundred years later. However, a number of large plantations were operated during the first half of the nineteenth century, principally in the southeastern part of the county. Each plantation supplied most of its own needs. Corn, wheat, oats, pork, and some beef were the staple products. Many other minor crops, which later included cotton, were also grown for home use. Ironworks, established at Cherokee Ford on Broad River, continued in operation until the close of the civil war.

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[a] As Mr. Drake was ill during a considerable part of this survey, the report was prepared largely by Mr. Belden.

Corn, wheat, and pork were the products first sold to the nearest towns, and by 1850 a little cotton was produced on the plantations near Broad and Pacolet rivers. A railroad from Spartanburg to Columbia was built through Union County in 1858, which soon gave a new impetus to cotton growing, then a young industry in this section. Horsepower gins were built before the war, but the cotton used at home, as most of it was at that time, was still often separated from the seed by hand.

In 1873 the main line of the Southern Railway was completed through what is now Cherokee County, and the town of Gaffney founded near Limestone College. Up to this time little cotton had been sold from the central and northern parts of the county, but with the new means of transportation and the increasing demand for cotton the valuable farming land of this region was soon put in cultivation to this staple. White farmers settled upon new land that could be rented or purchased at a low figure, and much of the land now under cultivation has not been cleared more than twenty-five or thirty years. Its value near Gaffney was from $1.50 to $3 an acre in 1873, whereas it now brings $25 an acre. Farther from town the land, bought for $8 in 1890, is now worth $20 to $25 an acre.

The farming population increased very rapidly, as much as one-third in some parts of the county, between 1880 and 1890. In 1886 and 1888 the Marion and Kingsville branch of the Southern Railway was constructed through Blacksburg and helped to develop the country along its route. Shortly after 1880 the first cotton mill in the county was built at Cherokee Falls, and in 1896 a large cotton mill was erected in Gaffney, since which time three other cotton mills have been built in Gaffney and one in Blacksburg.

CLIMATE.

The following table, showing the normal monthly temperature and rainfall, is compiled from records of the Weather Bureau stations at Gaffney and Yorkville. The latter town is situated in the adjoining county of York, but is near enough to make the figures applicable to the area surveyed. Unfortunately, normals of temperature were not available for Gaffney.

Normal monthly and annual temperature and precipitation.

Month.	Yorkville.		Gaffney.	Month.	Yorkville.		Gaffney.
	Temperature.	Precipitation.	Precipitation.		Temperature.	Precipitation.	Precipitation.
	°*F.*	*In.*	*In.*		°*F.*	*In.*	*In.*
January	43.1	3.86	3.48	August	77.9	4.96	6.03
February	46.4	4.77	3.88	September	73.6	4.38	3.92
March	53.1	4.90	5.36	October	62.0	3.78	2.94
April	61.6	3.78	5.85	November	53.1	2.98	3.64
May	71.3	3.58	2.46	December	46.1	2.98	3.56
June	77.1	6.75	4.58	Year	62.0	52.15	50.16
July	79.2	5.43	4.46				

The average annual rainfall of 50 inches is very well distributed throughout the year. The rainfall is heaviest during the three summer months when the temperature is highest and the growing crops need the most moisture and is lightest during the cotton picking in October, November, and December. The average date of the last killing frost in spring, as recorded at Gaffney, is April 5, and the first in fall is November 6. This gives a growing season of seven months, which is ample for maturing the cotton crop.

PHYSIOGRAPHY AND GEOLOGY.

The surface of Cherokee County is partly very rolling to hilly and partly gently rolling. The very hilly section, comprising about one-third of the area of the county, consists of an extension of Kings Mountain, which enters the county in the northeastern corner and extends southwesterly for a distance of 18 miles, terminating at a point on Thickety Creek 7 miles south of Gaffney. The average width of this region is about 8 miles. The rougher, more broken areas occur along Kings Creek and Broad River, especially along the upper part of the creek and near Cherokee Falls.

Partially encircling the Kings Mountain region and covering the remaining two-thirds of the county is a more level country, typical of the Piedmont Plateau. This is smoothest in the region northwest of Gaffney, where the streams are small and erosion less active. Here the only very rough areas are found in the vicinity of Thickety Mountain and in certain places along Thickety Creek. In other parts of the county, along the larger streams, the surface is generally much more hilly than in the interstream plateaus, but the southern part of the county also lies well for farming purposes.

As in nearly all parts of the Piedmont Plateau the regional drainage is very complete. The chief stream is Broad River, which flows through the county in a generally north and south direction. Into this stream empty the Pacolet River, forming the southern boundary of the county, and Thickety Creek, which, with their many tributaries, drain the most of the western and southern parts of the county. These streams have a generally southeasterly course. The drainage of the northern parts of the county also finds its way into Broad River through a number of smaller streams. Many of the streams afford water power, which has been partly developed.

The geological formations consist mainly of igneous rocks, although the Kings Mountain belt is made up of metamorphic rocks, and there are two occurrences of limestone. Granite is the prevailing rock, with gneisses and schists in the mountain area. The latter rocks give rise to the Cecil silt loam and Cecil fine sandy loam, and where the bedrock comes near the surface, as on the crests of the highest ridges, to small areas of Cecil stony loam. The three types derived in whole or for the most part from granites are the Cecil sandy loam, Cecil sand, and Cecil clay.

The geological formations are of some importance economically. Tin and monozite are being mined at present, while bodies of iron and some other minerals are known to exist. The limestone formation near Gaffney on Limestone Creek is quarried and burned.

SOILS.

With the exception of Meadow, the soils mapped in the present survey are residual. Eight distinct types are recognized, all of which have been found in earlier surveys within the Piedmont Plateau. The following table gives the name and extent of each type:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Cecil sandy loam	105,024	45.5	Meadow	6,208	2.6
Cecil silt loam	48,384	21.0	Iredell clay loam	1,344	.6
Cecil fine sandy loam	33,792	14.6	Cecil stony loam	832	.4
Cecil clay	22,592	9.8	Total	230,912	
Cecil sand	12,736	5.5			

CECIL SANDY LOAM.

The soil of the Cecil sandy loam, to a depth of from 5 to 12 inches, is a brown medium sandy loam. The subsoil, to a depth of 36 inches, is a compact friable clay of a light or dark red color, sometimes containing a little coarse sand and usually slightly lighter in texture than the subsoil of the Cecil clay. In the surface soil there is also often found considerable coarse sand and some small quartz fragments, the latter usually being more numerous on the ridges. Over a few square miles in the vicinity of Gowdeysville, small quartz and other rock fragments form from 5 to 15 per cent of the surface soil and give the type there the local name of "gravelly sandy land." From that locality extending westward to the county boundary both the soil and subsoil contain considerable coarse sand, owing to the coarser texture of the parent rock. The sandy loam soil is usually deeper and lighter textured where the surface is most level, which may be at the top of a ridge or at the bottom of a slope. A slightly heavier sandy loam is found where some washing has taken place or the underlying rock is finer grained.

Beginning north of Blacksburg, the type covers nearly all the northwestern third of the county. It also extends along the western side and again occupies most of the strip 5 or 6 miles wide across its southern end.

Much of the more level portion of the type lies to the northwest of Gaffney and needs but little terracing to prevent washing, the eroded portion being confined to a few cuts near the creeks.

Along Broad River and Buffalo Creek and in the extreme southern part of the county along Pacolet River the type presents a rougher surface, because of its proximity to these larger streams, which flow in deep channels. A strip of country a mile or more in width along each of these streams and large inflowing creeks is formed of a succession of rounded hills. These hills are not often too steep or badly eroded to prevent cultivation, and the roads usually follow the wide ridges where very little erosion has yet occurred.

On even the most level tracts there is sufficient drainage to allow the surface water to run off. A large amount of the rainfall percolates through the soil into the heavy clay subsoil to be retained there for the future use of the crop. When the surface becomes dry it does not bake into a crust, but in its loose condition acts as a mulch to prevent the rapid evaporation of the soil water. This feature of the Cecil sandy loam causes the cotton crop to suffer more during a prolonged wet period than it does on the Cecil clay, from which the water runs off rapidly. But all crops stand a drought better on this type of soil than on the Cecil clay.

The soil owes its origin to the disintegration of the underlying granite, which is usually encountered at a great depth below the surface. Near the Cecil fine sandy loam and the Cecil silt loam, notably in the southeastern part of the county, the Cecil sandy loam is derived in part from gneiss and schist.

A larger percentage of the Cecil sandy loam is in cultivation than of any other soil type in the county. It is well adapted to cotton and the secondary crops of this region, and sells for $8 to $25 an acre. When a crop of cowpeas is grown about every third year, by thorough cultivation and the use of barnyard manure the yield of cotton will average from three-fourths of a bale to 1 bale per acre on this soil. On the other hand, where cotton has been continuously cultivated under the tenant system, with the exclusive use of commercial fertilizers, a low yield is secured, ranging from one-fifth to one-third bale per acre. The average yields, taking the type as a whole, are about one-half bale of cotton, from 12 to 15 bushels of corn, from 5 to 8 bushels of wheat, and from 2 to 3 tons of cowpea hay per acre.

The following table shows the results of mechanical analyses of samples of the fine earth of the Cecil sandy loam:

Mechanical analyses of Cecil sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13367	Soil	4.8	16.9	10.7	30.7	14.1	12.1	10.1
13368	Subsoil	2.9	7.3	3.5	11.5	4.1	18.4	51.9

A study of the manurial requirements of this soil was made in the Bureau laboratories by the paraffined wire-basket method. The soil used was a brown medium sandy loam with a heavy, friable red clay subsoil. The field from which the sample was taken was cleared from an oak forest twenty years ago and was later abandoned, but for the last three years has been planted to cotton, receiving 200 pounds of complete mineral fertilizer each year.

The results obtained indicate that an excellent increase in productiveness may be secured by the use of manure or by nitrate of soda with sulphate of potash; that nitrate of soda alone or sulphate of potash alone will give a medium increase, while lime alone or acid phosphate alone will give little if any increase. Cowpeas and lime gave only a small increase, but in field practice would probably prove more beneficial.

Those farmers interested in making field tests along the lines indicated should bear in mind that wheat plants were used as an indicator in the above experiments and that the results are not held to be strictly applicable to other and unrelated crops or to fields which have received treatments essentially different from that from which the sample was taken.

CECIL CLAY.

The Cecil clay consists of a heavy reddish-brown loam or clay loam, 5 inches in depth, underlain to a depth of 36 inches by a heavy red clay, which is rather friable and slightly micaceous. On the surface over about half of the area of the type are found fragments of quartz, granite, and gneiss, ranging in size from 2 to 6 inches in diameter.

The more stony areas lie in the southern and southeastern parts of the county.

The largest body of the type lies southwest of Gaffney along Thickety Creek, the remainder being scattered throughout the county in smaller tracts. East of Blacksburg the type occurs on steep hill slopes, surrounded by the Cecil silt loam. Here the soil is rather silty and the surface rougher than is usual for the Cecil clay, although nearly all of the type in the county is hilly—a larger proportion of it being subject to destructive washing than in any other of the types. Even where most level the surface is always rolling enough to allow water to escape rapidly. Both soil and subsoil, owing to their rather impervious nature, absorb water slowly, and crops can withstand a wet season better on this type than on any of the other soils in the county. During a dry season, however, a hard crust is apt to form on the surface and crops suffer for the lack of moisture. This condition is avoided where good cultivation is practiced and the soil is kept supplied with humus by growing cowpeas or by applying barnyard manure.

The Cecil clay, like the Cecil sandy loam, is derived mainly from granite, but also in small part from gneiss and schist. Some areas were once covered with a sandy loam, and but for erosion would be classed with the lighter textured soils. The washed areas are found more often where the type occupies the long, rough slopes next to the large streams.

The Cecil clay on the steeper banks and ravines is in forest and probably best suited to this use. It is in general well adapted to pasture grasses, and as much of it washes badly when plowed Bermuda grass might be planted and stock raising carried on with profit as an adjunct to cotton growing. Besides the direct profit to be realized from stock raising a much larger supply of manure would be thus furnished each year to keep the cotton land in a productive state.

The type is devoted largely to cotton, the average yields being from one-third to two-thirds bale per acre. Corn averages from 10 to 15 bushels and wheat from 5 to 10 bushels per acre.

Farms on this type now sell for $7 to $20 an acre, the price varying with the topography and the improvements.

The following table gives the average results of mechanical analyses of typical samples of the fine earth of the Cecil clay:

Mechanical analyses of Cecil clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13822, 13824	Soil	2.6	7.6	5.9	16.9	15.7	21.5	29.7
13823, 13825	Subsoil	.9	4.9	3.9	11.2	11.2	19.0	48.5

A study of the manurial requirements of this type was made, using a large sample of this soil collected one-half mile north of Wilsons Chapel. The soil at this point is a heavy dark-red loam or clay loam to a depth of about 5 inches, contains about 3 per cent of quartz fragments, and has a red clay subsoil. The field from which the sample was taken is a terraced hillside, which was cleared twenty or twenty-five years ago, and has been planted to cotton with an occasional crop of wheat ever since. For the last few years it has received an annual application of mineral fertilizer.

The results obtained by the paraffined pot method indicate that a good increase in productiveness may be obtained by the use of manure or of nitrate of soda with sulphate of potash. When lime and acid phosphate were added to the latter treatment the conditions showed a further slight improvement. Nitrate of soda alone or cowpeas and lime gave a fair increase, while lime, sulphate of potash, or acid phosphate alone showed little if any benefit.

In these tests wheat plants were used as an indicator, and the results are held to be applicable only to related crops and to fields which have received treatment similar to that from which the sample was taken.

CECIL SAND.

To a depth of from 12 to 20 inches the Cecil sand is a light-gray coarse or medium sand. The medium-textured soil is especially pronounced in areas adjacent to the Cecil fine sandy loam. The sand particles are always rough and angular. The first 5 or 6 inches of soil is loamy and contains more vegetable matter than at a lower depth. The subsoil to a depth of 36 inches is a yellow or light-red clay that contains considerable sand. On some of the ridges and hills there is from 10 to 20 per cent of quartz fragments in the surface soil.

The Cecil sand occurs in six small areas near the North Carolina State line and in other areas lying in the southern part of the county. The largest area, extending northeast from Asbury and Dawkins Mill, covers about 10 square miles. Areas too small to map occur in the Cecil sandy loam.

The areas of the type in the northern part of the county have a slightly greater elevation than the surrounding soil types, but the surface is only gently rolling and not subject to washing. In the southern part of the county the topography is a series of low, rounded hills. Here the deepest and best soil is on the hilltops and in flat areas near the streams. The steeper slopes are subject to erosion, and on them partly disintegrated rock is often reached within less than 3 feet of the surface. The type is always rolling enough to give good drainage. At the same time the heavy clay subsoil retains moisture well, and all crops, especially cotton, give good yields even in dry seasons.

The Cecil sand has been formed from a coarse-grained, light-colored granite. This rock in its partly disintegrated state is seen in all the washouts at from 3 to 10 feet below the surface.

Nearly all of the type is under cultivation. It is a good soil for cotton, and, in fact, all the farm crops do fairly well. The good effects of manures and commercial fertilizers are quickly seen on this soil, but the benefit is not so lasting as on the heavier soil types. It is an excellent soil for cowpeas, and as it is very important to keep a supply of vegetable matter in the surface soil to retain the moisture and maintain the best tilth this crop should be grown on every field as often as once in every three or four years. Sweet potatoes and watermelons, which do well, are grown for home use. The average yield of cotton is one-third to one-half bale, corn from 5 to 15 bushels, and cowpeas from 2½ to 3 tons of hay per acre. Land of the Cecil sand type sells for $7 to $15 an acre.

The following table gives the results of mechanical analyses of fine-earth samples of the Cecil sand:

Mechanical analyses of Cecil sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13834	Soil	4.8	16.3	7.7	30.9	15.9	16.7	7.2
13835	Subsoil	1.6	8.3	4.8	19.5	15.0	21.2	29.6

CECIL SILT LOAM.

The Cecil silt loam is a loose gray silt loam, with a depth of 10 inches, changing to a compact red silt loam and underlain at 14 inches by a red silty clay. On a few of the higher ridges, where the parent rock is near the surface, the subsoil is a heavy red silt loam instead of a clay, while on the more level parts of the type it is a heavy clay containing but little silt. The surface soil on many of the ridges and some of the hill slopes contains from 10 to 30 per cent of quartz fragments, due to the presence in the underlying rock of veins of quartz, which weathers very slowly. Where most numerous, the fragments interfere somewhat with cultivation, but the soil is no less productive on that account.

The Cecil silt loam occurs in one continuous body, averaging 6 miles in width, that reaches from the northeastern part of the county to a point 5 miles south of Gaffney. Within its borders there are small areas of the Cecil fine sandy loam, Cecil clay, Cecil stony loam, and Meadow.

The topography of the type is mostly rolling, but becomes hilly near the streams, as well as next to the areas of the Cecil stony loam and along some few steep ridges where the underlying rock comes near the surface. Low, rounded hills with many gentle slopes well suited to cultivation compose most of the area.

The Cecil silt loam is derived from the metamorphic rocks common to the Kings Mountain ridge and other parts of the Piedmont Plateau. These rocks consist of gneiss and schist. Because of the broken surface features of portions of this type more of it is in forest than any of the other types, except the Cecil stony loam. The steepest hillsides should never be deforested, as destructive washing would follow. There are a number of fenced pastures where dairy cattle and other live stock are kept. Besides supplying the needs of the farmer, a portion of the milk and butter, as well as some beef, is sold in the local markets. If stock raising were generally introduced on this type, much of the land too rough for cultivation could be put to good use as pasture. Cotton has not been cultivated so long on this type as on the others in the county. The gradual lessening of the productiveness of the soil where plowed every year will soon become apparent, as is now the case with the older cotton fields. The use of manure and the rotation of cotton with other crops, including cowpeas, will be necessary to keep the soil in a profitable producing state. As on the other soils, cotton is at present practically the only money crop, but its economical production on this soil depends to a greater degree than on the other types upon the practice of a proper rotation and on the combination of stock raising or dairying with cotton growing.

Farms on the Cecil silt loam sell for from $6 to $15 an acre. Two-thirds of the type lies within less than 4 miles of a railroad station. The average yield of cotton is nearly a half bale per acre, corn from 6 to 15 bushels, and cowpeas from 2 to 3 tons of hay per acre.

The following table gives the average results of mechanical analyses of typical samples of the fine earth of the Cecil silt loam:

Mechanical analyses of Cecil silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13371, 13838	Soil	0.5	1.2	0.9	5.3	15.8	57.1	18.6
13372, 13839	Subsoil	.1	.6	.6	2.9	7.9	51.3	36.0

In order to study the manurial requirements of this soil, a large sample was taken one-half mile south of Sardis Church. The soil at this point is a loose light-gray silt loam, containing about 10 per cent of quartz fragments, underlain by a heavy red clay subsoil. The field from which the sample was taken occupies a terraced hillside, was cleared twenty-seven years ago, and has since been farmed continuously to cotton with an occasional crop of wheat, the yields being low. For the last few years an annual application of 200 pounds per acre of a complete mineral fertilizer has been used.

The results obtained by the wire-basket method indicate that an excellent increase in productiveness may be obtained by the use of manure, cowpeas, and lime, or of a complete fertilizer with lime, much better results being obtained when the lime was added twenty days before the planting than when added immediately before. Nitrate of soda alone or lime alone gave a fair increase, while sulphate of potash or acid phosphate alone or in combination gave only a small increase.

In these tests wheat plants were used as an indicator, and the results are held to be applicable to this crop only and to the field from which the sample was taken. They are, however, probably applicable to this type of soil over a large part of the area.

CECIL FINE SANDY LOAM.

The Cecil fine sandy loam consists of a dark-gray fine sandy loam, 6 inches in depth, underlain to a depth of 36 inches by a light-red clay. The subsoil is similar to that of the Cecil clay and Cecil sandy loam, but is more friable and contains a slightly larger proportion of silt and finer grades of sand. The ridges and knolls are often strewn with quartz fragments, the quantity ranging from 10 to 30 per cent, but are seldom numerous enough to interfere greatly with cultivation.

Beginning at the State line northeast of Blacksburg, the main body of this type extends in a southwesterly direction in a belt from 1 to 2 miles in width, and except for one break, between Gilkys and Abingdon creeks, reaches entirely around the Cecil silt loam. Another considerable area lies along Broad River, in the southeastern part of the county, and a number of smaller bodies occur in other parts of the county.

In both topography and texture the Cecil fine sandy loam is an intermediate type between the Cecil silt loam and the Cecil sandy loam. It occupies a series of low, rounded hills with gentle slopes and has good drainage.

The Cecil fine sandy loam is derived from the coarser crystalline metamorphic rocks of the Kings Mountain ridge. These are usually far below the surface, but are exposed on a few of the ridges. Between Limestone and Thickety creeks there is about 1 square mile of the type that varies somewhat from the typical description, being derived from a slightly different metamorphic rock. Here the subsoil is yellow instead of red.

The Cecil fine sandy loam is considered a good cotton soil, one-half bale per acre being about the average yield. Corn averages from 7 to 15 bushels, wheat from 5 to 10 bushels, and cowpea hay from 2 to 3 tons per acre. Farm land of this type sells at from $8 to $20 an acre.

The following table gives the average results of mechanical analyses of fine-earth samples of the Cecil fine sandy loam:

Mechanical analyses of Cecil fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13369, 13476	Soil	0.8	2.4	2.8	28.5	31.8	25.1	8.4
13370, 13477	Subsoil	.1	.9	1.1	12.3	16.1	20.0	49.3

A sample of this soil was collected 2 miles southwest of Gaffney, and a study of it made by the paraffined wire-pot method to secure information concerning its manurial requirements. The soil at this place is a light-brown fine sandy loam, with a light-red clay subsoil. The field from which the sample was taken has been in cultivation for about twenty-five years, being planted a larger part of the time to cotton, with an occasional crop of corn or wheat. Two hundred pounds per acre of a complete mineral fertilizer have been used annually for the last few years.

The results obtained indicate that an excellent increase in productiveness may be obtained by the use of cowpeas and lime, a complete mineral fertilizer and lime, or of manure alone; that nitrate of soda alone produced a large increase, and that lime alone produced a fair increase. Lime when added at the time of planting was much less effective than when added several days before planting. Sulphate of potash alone gave a very small increase and acid phosphate a slight decrease.

In these tests wheat plants were used as an indicator, and the results are held to be applicable to this crop only and to the particular field from which the sample was taken, but are probably applicable in a general way to other crops and to this soil over a large part of its area.

CECIL STONY LOAM.

The interstitial soil of the Cecil stony loam, to an average depth of 8 inches, is a loose silt or fine sandy loam. The subsoil, to a depth of 36 inches, is a red clay containing considerable silt. In both soil and subsoil there is from 20 to 60 per cent of quartz and metamorphic rock fragments, ranging from 2 to 6 inches in diameter. On the tops of the high hills there are spots strewn with rounded bowlders and massive slabs of rocks.

The largest single area of the type occurs along the ridge of Whitakers Mountain. Others occur on the tops of the highest hills of the main ridge that crosses Broad River at Cherokee Falls. Thickety Mountain is also capped by a stony area. Two small areas near Pacolet River differ from the remainder of the type in having a clay loam soil and a heavier clay subsoil.

The Cecil stony loam was formed from the metamorphic rocks which gave rise to the silt and fine sandy loam types of the county. It is now stony because the high, rough topography permitted the fine material to be washed to lower levels as fast as the rock disintegrated. The type is in forest and is best adapted to this purpose, or where more level to permanent pasture.

IREDELL CLAY LOAM.

The Iredell clay loam is locally called "black-jack land," because of the character of the timber growth. The surface soil, to a depth of 6 inches, is a dark-brown loam, containing considerable silt or fine sand. The subsoil is a heavy, plastic, tenacious clay of light-yellow color, extending to a depth of 36 inches, and is locally known as "pipe clay." In its lower depth the subsoil contains from 10 to 15 per cent of particles of rotten rock. The top soil contains from 10 to 25 per cent of rock fragments, varying from particles the size of gravel to pieces 5 inches in diameter.

Four areas of the type are located near Wilkinsville. An area in the southwest corner of the county differs from the rest of the type in that the surface soil, 8 inches in depth, is a coarse light-gray sandy oam. Here the surface is gently rolling, which makes it desirable and for tillage. The rough, stony, and hilly portion of the type is not well suited for farming, although on the eastern side of the county some areas are under cultivation. The fragments on the surface are mostly of the dark-colored, fine-grained basic rock from which the soil is derived. A few, however, are of gneiss or schist that give origin to the adjacent soil types, and these have also assisted to a small extent in giving the surface soil its silty and fine sandy texture.

Although nearly all of the Iredell clay loam in the county could be tilled, the roughest and stoniest areas, where not now in forest, could no doubt be more profitably used as pasture than as cultivated land. Where cultivated it is a fair soil for both cotton and corn. In addition to the usual commercial fertilizers, kainit is used by some farmers. It is said to prevent the rust of cotton. One-third of a bale of cotton and from 8 to 10 bushels of corn are the average yields secured.

The following table gives the results of mechanical analyses of the fine earth of Iredell clay loam:

Mechanical analyses of Iredell clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13842............	Soil.........	2.6	4.9	2.2	8.3	33.7	32.7	15.7
13843............	Subsoil.....	.6	2.7	3.5	13.5	19.4	22.1	38.3

MEADOW.

The Meadow type of soil varies from a compact silt loam to a compact fine sandy loam and occasionally to a medium sandy loam. The texture is nearly always uniform to a depth of 36 inches. It has slightly more vegetable matter at or near the surface and is more compact below. The silt loam areas are found generally on the creeks and the sandy loam areas on the rivers. There are, however, small strips of Meadow on every stream where the three different textures of soil occur.

Even along the smallest creeks are found strips of Meadow suitable for cultivation. In the bends of the larger streams the Meadow land sometimes extends back a fourth of a mile.

Nearly all of the type lies at a sufficient elevation above the bed of the streams to give excellent drainage. One exception to this, however, is on the lower part of Thickety Creek, where overflows occasionally occur. Here the areas have been allowed to grow up in forest. The highest part of the bottoms sometimes lies next to the river channel, and in such cases that part next to the upland is made tillable by surface ditches leading into the streams.

The soil is formed from material washed from the uplands and deposited at the time of the periodical overflows, which usually occur before planting time. The finer sediments are laid down by the slow currents next to the upland, where the silt and heavier fine sandy loam are located. Along Pacolet River there are also occasional narrow strips of coarse sand next to the stream bed.

Excepting the coarse sand strips just mentioned, which are not cultivable, the crop value of the Meadow does not vary much with the texture of the soil. The fact that it is near the streams and at the foot of hills insures a good supply of moisture, an important factor in making it a uniformly productive soil, whatever the texture may be. It sells for more than the adjoining upland types. The Meadow is a good cotton soil where well drained. It is the best corn soil in the county, and is cultivated largely to that crop. Corn yields from 20 to 30 bushels per acre when grown continuously, if cowpeas are sown thickly in the field each year after the last cultivation and the vines then left on the ground.

AGRICULTURAL METHODS.

The extensive one-crop system usually practiced by cotton planters is not followed altogether by the more progressive farmers in Cherokee County. They are plowing deeper and pulverizing the seed bed more thoroughly, are adopting a rotation in which cowpeas are included frequently, and are saving and applying to the fields all the manure of the farm. Thus the old method of growing cotton year after year on the same field until the surface soil becomes so exhausted of vegetable matter and the land so badly washed that it will no longer yield a paying crop has been more or less changed for the better by nearly every farmer in the county. About ten years ago terracing to prevent washing came into general use in this county.

It is now more often the custom than formerly to alternate cotton with some other crop, usually wheat. Many of the farmers object to following corn with cotton, even though cowpeas are sown in the corn at its last cultivation. A rotation recommended by many good farmers is cotton two years, corn with cowpeas the third year, and wheat and cowpeas the fourth year. The cowpeas sown in the corn are picked by hand, the vines being left on the field. After harvesting the wheat there is ample time to grow a crop of cowpea hay. When it is desired to grow cotton on the same land oftener than two years in every four wheat and cowpeas may follow the cotton, making a two-year rotation. Land can not be prepared so early in the fall for wheat after the cotton crop as when it follows corn, which is some objection to the latter arrangement. One great advantage in growing wheat after either crop is to protect the land from washing during the winter. The vegetable matter left in the soil by the two crops of cowpeas in the above four-year rotation puts the land in very good condition for the two years' cultivation of cotton.

Besides the value of incorporating vegetable matter in the soil by the decay of the roots of the cowpeas, in order to increase its productiveness, experience has shown that much less terracing is needed in a field that is kept supplied with humus by a rotation of cotton with cowpeas and the use of farm manure. As the terraces occupy a good deal of the land and are more or less a hindrance to cultivation, any farm methods or crop rotation that will lessen their number and at the same time check or prevent washing should be received with favor.

It is evident that cowpeas in common with other legumes have a very beneficial effect on the physical condition of the soil, besides their important functions of gathering nitrogen from the air, and that they also make the most nutritious and cheapest hay crop of the county.

In this county commercial fertilizer is applied at the rate of 50 to 70 pounds per acre for corn, and usually 200 pounds per acre for cotton. The brands in most common use contain 8 or 9 per cent of phosphoric acid and at least 2 per cent of both nitrogen and potash. It is used not alone to increase the yield but to hasten the growing and maturity of the cotton crop, for in some seasons the latest bolls are caught by the frost before ripening. A few farmers apply two or three times the above amount of fertilizer for cotton while others obtain good yields with the use of very little or no commercial fertilizer, depending mostly on thorough tillage, the use of barnyard manure, and a short crop rotation with cowpeas for successful results. Many have replaced the ordinary one-horse for the two-horse plow, which turns a furrow 6 or 8 inches deep instead of the usual 3 inches. In preparing the land for the crop the soil is fined by harrowing either before or after bedding, and then frequent and careful tillage is practiced during the growing season.

AGRICULTURAL CONDITIONS.

According to the census of 1900 over three-fourths of the area of Cherokee County was then included in farms. The average size farm is given as 84 acres, 37 acres of which is improved land, and the total assessed value of farm land in the county was $1,635,430, or $8.30 an acre. The buildings on a tenant farm usually consist of a two or four room house, a small barn, a wagon shed, and a corn crib. On each plantation, which generally includes three or four tenant farms, there is a large two-story house and commodious outbuildings. Single farms of 100 to 150 acres worked by the owner are characterized by neat, substantial buildings, and these are increasing in number with the advance in the price of land.

According to the last census only 28 per cent of the farms in the county are operated by the owners. This shows that the tenant system largely prevails, as elsewhere in the cotton-producing States. Each tenant cultivates a one or two horse farm, consisting of 30 and 60 acres of plowed land, respectively, about half of which is planted to cotton. If the tenant furnishes the working stock, which is usually the case, the landowner receives as rent one-fourth of the cotton and one-third of the corn produced and pays in the same proportion his part of the cost of the fertilizer used and of ginning. On some of the less productive farms his share is only one-fourth of each crop. When the owner furnishes the working stock, etc., his share is generally one-half of both crops. Sometimes the tenant pays a stipulated rent of 1,000 to 1,500 pounds of lint cotton per one-horse farm and furnishes everything. Usually a tenant remains for a number of years on the same farm. Many of the negro tenants have been on the same plantations all their lives. In the southeastern part of the county, which is the oldest settled portion, about one-third of the tenants are colored at the present time, but the proportion of negroes is much smaller in other parts of the county. The negroes have gradually moved into the towns and white farmers have taken their places.

Hired labor is rather scarce. Fifty or 60 cents a day, including one meal, or $8 to $12 a month, with board, is the average wage. Hired labor is in greatest demand during cotton-picking season. Forty cents per hundred pounds, with 50 cents per hundred for the last picking, is the price paid.

The last census shows that more than one-half of the cultivated land in the county is devoted to cotton, one-third to corn, and the remainder mostly to wheat, oats, cowpeas, sorghum, and sweet potatoes. Garden vegetables and orchard fruits are grown with success for home consumption.

It is evident that the acreage in cowpeas has increased during the five years since the census of 1900. The value of this crop, which is discussed in this report under "Agricultural methods," is becoming more generally recognized each year. It is safe to say that the most profitable farming in the future will not be in increasing the acreage devoted to the cotton crop, but rather in adopting the best methods to increase the crop yields per acre.

It is seen from this report that the different soils of the county, as elsewhere on the Piedmont Plateau, are all characterized by having a heavy clay subsoil, whether the top soil be a clay loam, a sandy loam, or a sand. This gives a greater uniformity in crop value than is usually the case where the surface soils are so much unlike in texture. The Cecil clay and Cecil sandy loam are recognized as the strongest soils in the county, being the best for cotton, and, except Meadow, the best for corn of any of the types. The Cecil sand, Cecil silt loam, and Cecil fine sandy loam are good cotton soils, and the latter at least is better adapted to corn than the Cecil sand. These three soil types respond quickly to the application of fertilizers or manures and are much easier to cultivate than the Cecil clay. Because of their lighter texture and steeper topography it is more necessary than on the heavier types to keep a supply of humus in the surface soil by crop rotation, including cowpeas, or in some cases by the production of manures through a combination of stock raising with cotton growing. A portion of the Cecil silt loam is too rough for cultivation, but well adapted to Bermuda grass pastures and cattle raising. The cotton-seed meal now shipped to distant States for cattle feeding might be used to good advantage at home if stock raising or dairying were made one of the important farm industries.

Direct transportation to all the large and local cotton markets is afforded by the railroads crossing the county. The main line of the Southern Railway, from Washington to Atlanta and New Orleans, passes through the central part from the northeastern corner to its western side. Points to the northwest and southeast are reached by the Marion and Kingville branch of the Southern Railway, which crosses the northeastern part of the county. The wagon roads are kept in excellent repair, making it possible to get the cotton crop to market cheaply from any portion of the county.

SOIL SURVEY OF SPALDING COUNTY, GEORGIA.

By **J. E. LAPHAM, W. S. LYMAN, and CHARLES W. ELY.**

LOCATION AND BOUNDARIES OF AREA.

Spalding County is situated in the west-central part of Georgia. The latitude and longitude at the Georgia experiment station, which is located near the center of the county, was determined for astronomical purposes in 1900 and found to be longitude 84° 24′ 58″ west, latitude 33° 13′ 55″ north. Griffin, the county seat, is 43 miles south of Atlanta, and 250 and 69 miles, respectively, northwest of Savannah and Macon.

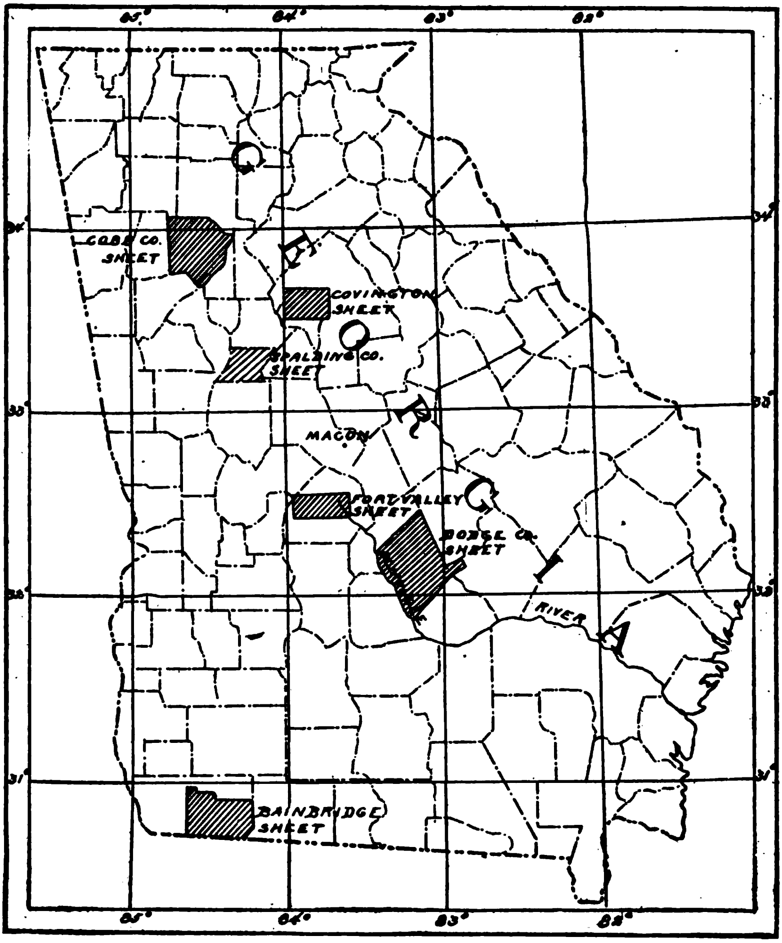

FIG. 13.—Sketch map showing location of the Spalding County area, Georgia.

Spalding County is bounded on the north by Henry and Clayton counties, on the east by Henry and Butts, on the southeast by Monroe, on the south by Pike, and on the west by Meriwether, Coweta, and Fayette counties. The county contains 130,944 acres or about 205 square miles.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Some difficulty was found in securing facts regarding the early history of Spalding County, and specific data as to the date of the first settlement are wanting. The first settlers began to arrive, however, somewhere about 1815 to 1825, some of them coming from Virginia and other nearby States, but most of them from other counties of Georgia. Spalding was for a long time, and until its separate organization in 1851, a part of Pike County, the seat of government of which was Zebulon.

The early agricultural products of the area were corn and wheat, the acreage of the former being by far the larger. At the time of the outbreak of the civil war about one-half of the county was yet wooded, and there were few towns and railroads. It was necessary for the farmers to produce a great part of the breadstuffs, meats, etc., needed for subsistence. The production of corn was nearly 25 per cent greater in 1860 than in any year since. The number of live stock was also greater, especially sheep and hogs. The stock required little attention, getting almost if not all their food from the pastures and mast found in the woods and from the cane growing along the streams. Cotton was not an important crop until about the year 1860.

The history of the agricultural development of this section of the State is one of steady progress until the outbreak of the civil war. The farmers were prosperous and able to produce, and to a great extent did produce, everything needed on their own farms.

Between 1870 and 1880 the farmers became more accustomed to the changed conditions and the production of cotton doubled, although there was only a comparatively small increase in the production of corn. At the end of this decade cotton had become the staple crop and the progress since then has been simply a development of this industry.

By 1890 nearly all the land suited to agriculture had been brought under cultivation and any increase in farm products since then has been the result of a dividing up of farms and of improved methods.

CLIMATE.

The following table, compiled from Weather Bureau records, gives the monthly and annual mean temperature and precipitation for Experiment:

Normal monthly and annual temperature and precipitation.

Month.	Experiment.		Month.	Experiment.	
	Temperature.	Precipitation.		Temperature.	Precipitation.
	°*F.*	*Inches.*		°*F.*	*Inches.*
January	44.0	3.89	August	78.2	6.14
February	47.3	5.00	September	73.7	1.93
March	53.8	4.91	October	62.8	2.93
April	62.8	3.50	November	53.2	2.67
May	71.8	2.82	December	45.9	3.23
June	78.6	4.53	Year	62.6	47.65
July	79.4	6.10			

Complete records of the killing frosts are not obtainable, but from records covering 1898, 1900, 1901, 1902, 1903, and 1904, the averages seem to be about March 10 and November 9 for the last and first killing frost in spring and fall, respectively. This gives a growing season, free from frosts, of 244 days. In the present year (1905) a frost severe enough to kill many young peaches occurred April 17.

PHYSIOGRAPHY AND GEOLOGY.

Spalding County, being situated in central Georgia, is in the physiographic province known as the Piedmont Plateau. This plateau extends across the State in a northeasterly-southwesterly direction, with Augusta, Milledgeville, and Columbus approximately on the boundary line between it and the Coastal Plain. The general elevation of Spalding County is about 1,000 feet. The country is rolling to hilly, and is drained by numerous small streams tributary to Flint and Towaliga rivers, which form, respectively, the partial western and eastern boundaries of the county. The general drainage of the county is to the south. The streams have eroded quite deep valleys into the plain, with a difference in elevation between the stream bottoms and hilltops of from 20 to 200 feet. Though the soil washing is in many cases rather severe, the slope of the hills is not usually very steep, infrequently exceeding 10°. Along many of the larger streams alluvial flats have been built up. These attain a width of more than one-fourth of a mile in some localities along Flint River and Line Creek, but on the smaller creeks of the county they are seldom more than a few rods wide.

The underlying rock formation of Spalding County consists of granite, gneiss, schist, and other metamorphic and eruptive crystalline rocks. A good quality of granite is quarried to some extent a short distance north of Griffin, where, in the valley of Cabin Creek, a few irregular patches are exposed and wider areas are but thinly covered with soil. With the exception of a very few of these outcrops, however, the underlying rock of the county is covered with soil ranging from 2 or 3 to 20 or more feet in thickness. The depth varies considerably, owing to the fact that some of the rocks disintegrate and form soil more rapidly than others, and also because of the difference in the rapidity of erosion and transportation.

The soils of the area are residual in origin, being formed directly from the rocks which they overlie. The continuous and ever active physical and chemical forces operate in disintegrating the rock into finer and finer particles, forming them, after weathering and the incorporation of organic matter, into a complete soil, capable of the support of vegetable life. The arrangement of the mineral particles, as into sands, loams, clays, and the heavier subsoil underlying the looser, more porous top soil, is effected by gravitation and the assorting power of water, facilitating the removal of the finer and more completely weathered particles, and leaving at the surface the coarser and more resistant grains of quartz, feldspar, etc.

The heavy red Cecil clay, which often exhibits particles of mica, is more readily formed from the fine-grained micaceous schist, while the Cecil sandy loam and Cecil sand is more uniformly found in areas where the coarser grained granites and gneisses predominate.

Probably not over 10 per cent of Spalding County is in forest, the tree growth consisting of shortleaf and loblolly pine, together with such hardwoods as white, water, willow, post, and black-jack oaks, and beech, dogwood, hickory, etc. Along the bottoms tulip and sycamore are present with an undergrowth of alder. Originally there were quite extensive groves of chestnut on the upland, but this species has almost wholly disappeared. Longleaf pine is occasionally, though rarely, seen.

SOILS.

The soils of Spalding County were separated into four different types. Cecil clay and Cecil sandy loam constitute the main body of the upland, the Cecil sand occupying but a few small areas. The other type—Meadow—is what is usually known as bottom land, and occurs only along the streams.

Areas of different soils.

Soils.	Acres.	Per cent.
Cecil clay	66,560	50.9
Cecil sandy loam	54,464	41.8
Meadow	9,472	7.0
Cecil sand	448	.3
Total	130,944	

CECIL CLAY.

The depth of the soil of the Cecil clay varies to some extent, but on an average it is about 6 inches. The material consists usually of a heavy red loam or clay loam, but sometimes has the consistency of a sandy loam at the immediate surface. The soil, however, is so shallow and the gradation into the heavy clay subsoil so abrupt that a considerable amount of the latter is turned up in cultivation, giving to the whole mass the physical character and agricultural value of a clay soil. The subsoil is a heavy compact red clay of fine, close structure, possessing good retentive power for moisture. It rests directly upon the crystalline rocks from which it is derived, and the depth ranges from 2 to 20 feet. Usually the distance to the partially weathered rock is 4 feet or more. In some localities from 5 to 20 per cent of stone is distributed in the soil and subsoil, but the quantity is seldom sufficient to interfere with cultivation.

The Cecil clay has been mapped in all parts of the area surveyed, but is confined for the most part to the central, northern, and northeastern parts of the county. The topography is rolling to hilly in character, the type in many instances occupying all the contours of a hill, though usually occurring on the side slopes that have been to a greater or less extent denuded of the coarser materials by rains. Though these slopes are often sufficiently steep to cause destructive washing, this tendency is corrected to a great extent by terracing. There is but a comparatively small proportion of this type of soil which has not sufficient surface slope to secure good drainage without resorting to artificial means, though underdrainage in some instances would serve to improve the condition of the flatter hilltops.

The soil is residual in origin and is formed by the weathering of the underlying crystalline rocks, consisting of granite, gneiss, and mica schist. In the case of the coarser grained, more siliceous granite and gneiss a longer time is required for the formation of the residual clay and its separation from the various grades of sand which the parent rock yields, but in the end there is little or no difference in the physical characteristics of the clay derived from the various rocks.

The Cecil clay is the strongest soil in the area for general farm purposes, and is well adapted to the production of grass , corn, wheat, and other cereals. Little grass is grown in the area at the present time, either for hay or for pasturage, yet it is believed that both clover and alfalfa would do well if a little patience were exercised to secure a catch. Cotton does well upon this type in favorable seasons, but it is not considered so safe a soil under varying conditions as the Cecil sandy loam. A number of fine peach orchards were seen on this type, and the adaptability of the soil for this class of fruits is evidenced by the superior quality and good yields secured. Apples also do well on this heavy type of land.

The principal crops grown are corn and cotton, the former yielding an average of about 15 bushels, and the latter from one-half to three-quarters bale to the acre, while under the most favorable conditions 1 bale to 1½ bales have frequently been grown.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Cecil clay:

Mechanical analyses of Cecil clay.

[Fine earth.]

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12850, 12848	Soil	1.9	6.1	5.2	28.8	8.4	12.7	36.7
12849, 12851	Subsoil	.4	1.6	1.9	15.2	6.6	15.3	58.9

CECIL SANDY LOAM.

The Cecil sandy loam, to a depth ranging from 6 to 15 inches, consists of a rather coarse sandy loam. It is gray at the surface and somewhat incoherent, but becomes yellowish and more plastic below 4 or 6 inches. The subsoil is usually a heavy red clay, sometimes containing a small amount of sand in the upper part of the section. Local spots are present in some of the smaller stream valleys where the subsoil is of a yellowish color down to a depth of about 2 feet, at which depth the red clay is encountered. The texture of the yellow clay is only slightly more sandy than the red clay, and the areas are usually not more than 2 or 3 acres in extent, and do not differ appreciably, in agricultural value, from the main type.

Cecil sandy loam covers 41.8 per cent of the entire county. The largest and most connected bodies of it occur in the southwestern part of the area, though there is an irregular distribution of it in other parts as well. The type occupies a rolling topography similar to that of the Cecil clay. The contours of the hills are well rounded, and the erosion of the streams has given them a relative elevation of from 20 to 200 feet. Though the soil is usually uniformly distributed, its greatest thickness is found in the flatter parts of the valleys, where a more abundant accumulation of sand results from the wash of the upper hill slopes.

The drainage is well established, and little or no ditching is required; in fact, free use of the terrace system of cultivation has been adopted to prevent the rain waters from running off too rapidly and causing denudation of the soil and destruction of the fields.

The Cecil sandy loam, like the Cecil clay, is a residual soil and is the result of the disintegration and weathering, less complete, of the underlying granite and gneiss. The individual sand grains present are mainly composed of quartz, though a considerable amount of feldspar is also to be seen in some localities where the surface of the fields appears whitest.

Under the varying conditions of temperature and rainfall the Cecil sandy loam is considered the safest soil of the area for cotton, though the capabilities of yield under the most favorable circumstances are not quite as great upon the sandy loam as they are upon the Cecil clay. Corn does fairly well upon this type, though not as well as upon the heavier clay. It is well adapted to watermelons, and upon the lighter, sandier phases of the type good yields and an excellent quality are produced.

The principal crops grown are corn and cotton, the latter having somewhat the larger acreage. Corn yields on an average about 12 bushels, while cotton produces about one-half bale under the average conditions of cultivation and fertilization. The greater proportion of the peach crop of the area is grown upon Cecil sandy loam, and the extension of the industry, which has already proved so profitable, might safely be undertaken. The variety grown to the exclusion of nearly all others is the Elberta, which is a native of Georgia and a great favorite, not only in the South, but with northern shippers and consumers.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Cecil sandy loam.

[Fine earth.]

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12840, 12844	Soil	4.8	18.2	10.7	26.7	8.5	16.8	13.8
12841, 12845	Subsoil.....	2.8	10.9	7.0	14.8	4.5	14.4	45.2

CECIL SAND.

The soil of the Cecil sand, which ranges from 8 to 24 inches in depth, consists of a rather coarse sand, light-gray, loose and incoherent at the surface, but becoming loamy and yellowish below 8 inches. The subsoil is a yellowish or slightly reddish sandy clay, which is more sandy in the upper section. The soil, while not very retentive of moisture, is loose and easily cultivated and does not wash to such an extent as the heavier soils, much of the excess rain water percolating downward into the soil instead of running off the surface.

The type occupies less than 1 per cent of the area and occurs in small isolated spots in the southwestern part of the county, the largest of these spots being less than a square mile in extent. It is generally found on the lower slopes of the hills and the natural drainage is adequate for nearly all purposes.

The Cecil sand has been derived from the coarser-grained varieties of the underlying crystalline rock, in the same manner as have the other upland soils of the area.

The type is very well adapted to the production of sweet potatoes, peanuts, watermelons, and crops requiring an early, warm soil, capable of very free drainage. It is also a suitable type for the earliest garden vegetables and for strawberries and other small fruits. The principal use of the type at the present time is for cotton, though some corn is also grown. The yields, however, are low and the profits small as compared with those from the heavier and more loamy soils.

The following table gives the results of mechanical analyses of the soil and subsoil of the Cecil sand:

Mechanical analyses of Cecil sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12846	Soil	8.6	26.2	16.3	27.4	5.0	10.0	6.2
12847	Subsoil	5.2	19.6	12.3	27.1	4.7	12.3	18.5

MEADOW.

The Meadow mapped in Spalding County consists of a heterogeneous mixture of soil materials, ranging from a fine clay and silt to a medium or coarse sand. This variation in texture and general characteristics is true not only of the section as obtained by boring and as seen in bank exposures, but of the surface of the soil as well. In some places the top soil is a heavy red clay not unlike that of the Cecil clay, underlain at a depth of a few inches by a dark-bluish mixture of sand, clay, and gravel, while perhaps a short distance away on the same stream bottom the surface of the Meadow will be a nearly pure sand, underlain in turn by layers of clay, gravel, and sand, more or less stratified.

The Meadow occurs as a narrow strip along the margins of some of the larger streams, and is derived from the sediments deposited by these streams in times of high water. The areas are nearly always poorly drained, but with ditching can be made very productive and valuable for the growth of corn, grass, and many of the vegetables. Many of these bottoms are at present covered with a growth of alder, willow, sycamore, and other trees and shrubs, while other areas which have been cleared make good pasturage for cattle.

AGRICULTURAL CONDITIONS.

The general appearance of the farms of Spalding County indicates a greater degree of prosperity than is found in many sections of the South. Many of the farmhouses are commodious and neatly painted, and large dwellings are not uncommon.

Something over 60 per cent of the land in Spalding County is under cultivation, and there is only a relatively small area that can not be used for some agricultural industry. The price of land varies from $5 to $100 an acre, the latter in a favorable location near Griffin, but the average value for the entire county is between $7 and $8 an acre. The farm lands are mainly rolling, but terracing and contour cultivation have become so common in recent years that comparatively little land has been rendered useless by washing. At the present level of land prices and rental values, farming lands are expected to yield a return of about 10 per cent on the money invested.

Tenants in Spalding County—and the proportion of tenants in the farming population is high—are more prosperous than the landowners. Where cotton is relied upon as the sole money crop, as it is in this county, the farmer often finds it difficult when prices are low to pay rent and buy necessary supplies. The better class of farmers produce most of the breadstuffs and meats needed for home use, as well as feed for the work stock, but the majority do not.

According to the Twelfth Census only 31 out of every hundred farms in the county are operated by the owners themselves. The rest are rented either for cash or a share of the crops produced. Cash rents range from $3 an acre upward. Tenants on shares may have only the land furnished them, in which case they receive two-thirds of the cotton, or the landlord may furnish teams, implements, etc., in which case each gets one-half the crop. About five-eighths of the tenants are negroes, and the share system is somewhat more common among them than among the whites. Only a few negroes own land. According to the Twelfth Census, the average-sized farm contains 93.6 acres, of which 56 acres are improved or cultivated land. The farms most numerous are those of 20 to 50 acres, but somewhat over one-half of the total land in the county is in farms of from 50 to 175 acres. There are a few farms of 500 acres or over, and a great many men own that much land or more. The large tracts are rented out in smaller areas, 25 to 30 acres, or about what can be cultivated with one horse.

Labor, which in this section is very largely colored, is regarded as reasonably efficient, especially in the growing of cotton. The hands receive from $9 to $15 a month and board. Cotton is picked by the hundredweight, the rate varying from 40 to 65 cents. Wealthy landowners who rent a considerable proportion of their land usually exercise almost as much supervision over their tenants as they do over hired labor. The supply of hands varies somewhat as the price of cotton. If cotton is high, a great many prefer to rent land. If it is low, they prefer to work as field hands. Sometimes it is hard to get enough field hands during the rush seasons to do the work as speedily as is necessary. The expenditure for labor for the entire county in 1899 was $65,200, or about $57 to the farm.

As already stated, cotton is the chief crop grown in Spalding County. Nearly one-half of the entire area of the land cultivated in any one year is planted to this crop. The average yield varies from one-fourth to three-fourths bale an acre. Fertilizers are generally used in the production of this crop, the most common material being cotton-seed meal and acid phosphate. Corn is the next most important crop, about 40 per cent of the cultivated land being devoted to this grain. The ears are gathered with the husks on, and only a few farmers utilize the fodder. Corn shredders are being introduced in the county, generally with satisfactory results. The average yield of corn varies from 8 to 12 bushels per acre. Wheat and oats are the next important crops, occupying, respectively, 5 and 4 per cent of the cultivated land. The average yield of wheat is 8 bushels per acre and of oats 12 bushels. As a rule these crops occupy only small areas, and, as a whole, are comparatively unimportant. The wheat grown here is of good quality, however, and it would seem that it should prove profitable to grow it more extensively. The Cecil clay is a good soil for wheat growing, and an average yield of 20 to 25 bushels would not be an unreasonable expectation if the soil were brought into the proper condition.

Not very much attention is paid to the production of hay. In fact, hay is shipped into this area and purchased by the farmers to feed to their stock. No clover or alfalfa is produced and only a limited quantity of cowpeas. Very few pastures are seen. It is very probable that the hay crop might be made profitable. The soils, especially the Cecil clay, should produce a good quality and yield, and if what were needed were produced at home it would keep a considerable amount of money in the county that is now expended for western hay. Cowpeas and similar plants would make good hay, and the stubble, if turned under, would increase the productiveness of the land by improving its physical condition and by adding organic matter and nitrogen—the element most needed by soils used almost continuously for cotton production. The rotation considered most suited to conditions by the best farmers is cotton one year, followed by corn or small grain, which is followed by cowpeas or some other hay crop. This is said to increase gradually the organic matter in the soil and to make it darker and more productive. As the color of most of the Cecil sandy loam and Cecil clay indicates, such a treatment of the soils is not general. Its introduction would probably greatly increase the money returns secured from these soils. The general custom is to grow cotton for one or two years, which is followed by corn, and this again by cotton. Occasionally cowpeas may be sown in the corn, but this is rare.

In addition to the crops already mentioned, relatively small areas are planted to Irish and sweet potatoes, and a few small areas to sugar cane and sorghum, to be manufactured into sirup, all for domestic use. The total value of orchard products in 1900 was $70,728, principally strawberries and peaches. Since then a great many peach orchards have been set out, and in time fruit growing will probably be an important industry. Peaches are grown on both the Cecil sandy loam and the Cecil clay, but the more hilly portions of the Cecil clay are probably better adapted to fruit growing on account of better atmospheric drainage and consequent less danger from frosts.

The same crops are generally grown on the two main soil types, and it can not be said that any great attention has been paid to the adaptation of soils to particular crops. The Cecil clay is said to produce heavier yields in favorable seasons, but the Cecil sandy loam is looked upon as a more reliable soil for a term of years, as crops on the heavier soil sometimes suffer during wet seasons. The more sandy soils are recognized as well adapted to watermelons, and in the past have been used for that purpose to some extent, but at the present time, except for home use, few are grown.

The area surveyed is well supplied with railroads. Both the Southern and the Central of Georgia systems cross the county in north and northwestern directions through Griffin. A branch of the Central reaches Griffin from the western part of the county, and a branch of the Southern also traverses that part of the county. Few farms are more than 8 or 9 miles from a railroad station.

The county also has a well-developed road system. Roads leave Griffin in all directions, and are intersected by frequent crossroads. There are few points in the county more than a mile from a county road. The roads are worked by convict labor, and are kept in fairly good condition most of the year. At present, however, efforts in road improvement are confined to grading and leveling. There is a great abundance of granite and other rock suitable, if crushed, for road material, and if this were utilized it would be possible to have a much better system than at present.

The county is only about 205 square miles in extent, and Griffin is the only town of any consequence. It is quite easily reached from all parts, and practically all of the farm products are marketed there. There are five cotton mills, and these handle all the cotton and cotton seed produced within the county, as well as some from adjoining counties. Points so far away as to be unable to haul cotton to Griffin ship it from the small stations found every few miles along the several railroads traversing the county.

SOIL SURVEY OF LEON COUNTY, FLORIDA.

By **HENRY J. WILDER, J. A. DRAKE, GROVE B. JONES, and W. J. GEIB.**

LOCATION AND BOUNDARIES OF THE AREA.

Leon County, situated in the north-central part of Florida, is bounded on the north by Gadsden County and the State of Georgia, on the east by Jefferson, on the south by Wakulla, and on the west by Liberty and Gadsden counties. From the latter two counties it is separated by the Ocklocknee River, a winding, erratic stream flowing from northeast to southwest. The shape of the county is irregular, as is evidenced by its diagonals, which are about 48 miles from northeast to southwest and 30 miles from northwest to southeast. The county has an area of 431,872 acres, or about 675 square miles, and in 1900 its total population was 19,887, of which number 3,886 were whites and 16,001 were negroes. The only town of importance in the county is Tallahassee, which in 1900 had a total population of 2,981.

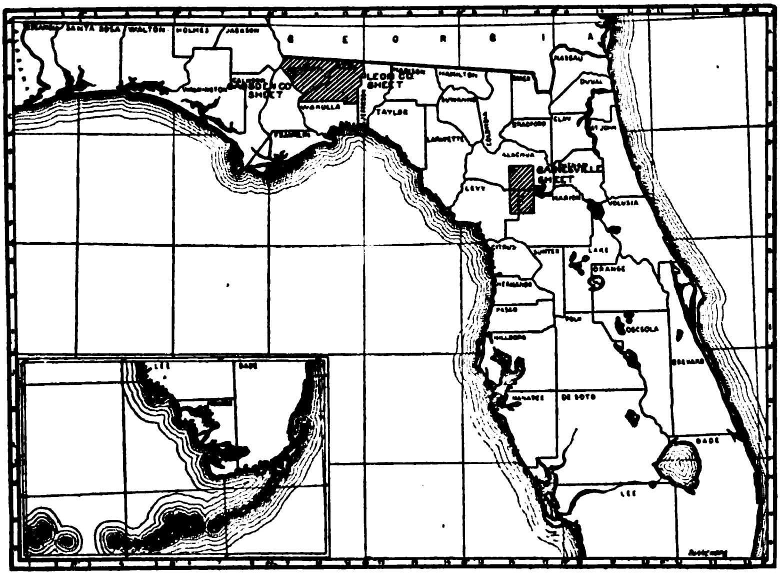

FIG. 14.—Sketch map showing location of the Leon County area, Florida.

The base map of the county, showing the location of the roads, towns, country post-offices, railroads, and streams, was constructed with the plane table by the field party as the soil mapping progressed. The county was originally plotted into sections, and many of the section lines are so definitely located at the present time by lines of trees, hedgerows, etc., that the base map has generally been made to conform to these long-recognized land lines, although few of the sections contain exactly 1 square mile.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The earliest settlements in Leon County were made by the Spanish, but the exact dates are not known. De Soto, after landing at the present site of Tampa in 1539, marched northward and spent the winter at Fort San Luis Hill, 2 miles west of Tallahassee. For two centuries Spain held possession of the region, but in 1763 Florida was ceded to the English. After the Revolutionary war Spain again obtained control of the territory, but in 1821 Florida was ceded to the United States. In 1823 Gadsden County was established, and in 1824 Leon was cut off from Gadsden, with the Ocklocknee River as the dividing line.

In 1823 the old Indian field of Tallahassee was selected as the site for the State capital, and two years later the cornerstone of the capitol was laid. Leon County was at that time an almost unbroken forest, but by 1830 its population, which had come mostly from Virginia, the Carolinas, and Georgia, was 6,494.

With the steady increase of population the development of agriculture was rapid. The land was divided into large plantations, which were worked with slave labor. Cotton was the principal crop, but beef was also an important product. Tilled fields were fenced and the remainder of the land—by far the greater part—was used as open range. In the winter seasons the fences were thrown down and the cattle allowed to roam over the entire country. The cattle were never housed, were fed neither grain nor hay, and at the age of 5 or 6 years—the usual time of slaughtering—dressed from 400 to 450 pounds. The uplands were then covered with open pine forests, while the hammock lands along the lakes and streams supported a growth of oak, hickory, beech, magnolia, bay, and a dense undergrowth. Where cleared these hammocks grew excellent crops of cotton, corn, peas, pumpkins, sweet potatoes, and sugar cane, without fertilizing. Until about fifteen years before the war every farmer raised sufficient corn, meat, and other supplies for his own needs, and bought little except mules, which were obtained from Kentucky and Tennessee. Improved herds of hogs and cattle were brought in from Georgia, the Carolinas, Kentucky, and Tennessee by settlers from these States, and many others were bought from drovers for the purpose of improving the native stock.

The early trading points were St. Marks, the nearest Gulf port, and Newport, a short distance farther north on the St. Marks River. There cotton was hauled by mule teams, which brought back dry goods, farming implements, machinery, and a few groceries, which had been brought by boat from New York and New Orleans.

About 1845 methods of farm management on the big plantations underwent a gradual change. Cotton, which had been the chief money crop, became almost the sole crop, thus necessitating the purchase of corn and meat, which hitherto had been grown at home. The disadvantages under this system of farm management soon became apparent, for the few large planters who retained the old system of growing their own supplies and all the small planters, since they followed the same practice, became far more prosperous, even before the outbreak of the war, than those who devoted all their energies to the production of cotton. After the war the price of cotton decreased rapidly, while the cost of supplies steadily advanced, and severe depression followed. Those, however, who adhered to the early system of growing their own supplies and producing cotton only as the principal money crop were the earliest to regain prosperity, and this fact led to the slow and somewhat erratic, yet on the whole secure, extension of the system.

CLIMATE.

The following table shows the meteorological records kept by the Weather Bureau station at Tallahassee, which is located near the center of the county, where the climatological influences are representative for the northern two-thirds of the county. Although the southern part of the area would probably show some variation from these observations, no records for that part of the county were obtainable:

Normal monthly and annual temperature and precipitation.

Month.	Tallahassee.		Month.	Tallahassee.	
	Temperature.	Precipitation.		Temperature.	Precipitation.
	°F.	*Inches.*		*°F.*	*Inches.*
January	51.5	3.51	August	79.1	7.44
February	54.6	5.73	September	76.7	4.64
March	59.2	5.59	October	67.8	3.42
April	66.9	1.99	November	58.9	2.58
May	74.5	3.48	December	52.8	4.10
June	78.8	6.36			
July	80.4	8.23	Year	66.8	57.07

The climate of the county is equable, the mean range between winter and summer being only about 20°, and extremes of temperature are rare. The highest temperature recorded in 1903 at Tallahassee, which is 253 feet above sea level, was 94° F. and the lowest 25° F. The county can not feel secure, however, from severe frosts, although these are very erratic in occurrence, and a period of several years sometimes elapses between them. The dates on which the first and last killing frosts of each season occurred are shown in the appended table of observations recorded in Tallahassee:

Dates of first and last killing frosts.

Year.	Tallahassee.		Year.	Tallahassee.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1896	Feb. 21		1900	Feb. 25	None.
1897	Jan. 30	Dec. 28	1901	Mar. 17	Dec. 15
1898	Feb. 22	Nov. 27	1902	Feb. 18	Dec. 27
1899	Mar. 8	Nov. 4	Average	Feb. 24	Dec. 8

More than half of the annual precipitation falls during the growing season, and the humidity is relatively high. Recently, however, lack of rain at critical times during the growing season has occasioned some injury to crops.

PHYSIOGRAPHY AND GEOLOGY.

The topographic features of Leon County are never abrupt or even roughly broken, but present a gently rolling or broad, wavy appearance, varied here and there by minor hills and valleys. The general trend of the surface features is from east to west, and in this relation to each other a series of broad physiographic divergencies is apparent. From some of the higher hilltops one may observe a general valley crossing the county laterally, including a width perhaps of several miles before another series of as high hills meets the eye. Such valleys, however, are so marked by lower hills, ridges, and more minor elevations that level areas of any considerable extent are rare. Again, the valleys are comparatively narrow, and with the adjoining series of hills, ridges, and spurs form a succession of well-marked depressions and elevations, which illustrate the effects of active stream work upon a plane formerly elevated about 200 feet above tide. The depressions are mostly flat-bottomed valleys, breaking up into numerous branches, which become gradually narrower until they form mere shallow ravines for some distance from their inception. The streams which occupy these valleys follow a winding course, in which the curves steadily lengthen as the valleys widen, and the current of the stream is correspondingly diminished. These hills are seldom more and usually less than 100 feet above the valley bottoms. From Tallahassee north the general land level gradually ascends for a distance of several miles and then descends very slightly from a somewhat faint divide until near the Georgia line, toward which it again ascends. From Tallahassee south there is a gradual slope to the Gulf coast and the surface, marked only by long, low swells instead of by ridges and hills, presents a strong contrast to the configuration of the northern part of the county. The swells are usually broad-topped, with very gradual slopes, and although their mean elevation decreases slowly, it is nevertheless constant with the approach toward the Gulf. This general slope is almost always covered with dull yellow or white sand quite distinct from the the bright-red color in the northern part of the county.

The succession of little hills and valleys, which give to the county as a whole a topographic aspect so varied and attractive, is caused by the mutual relations of the limestone which underlies the entire region and the superposed beds of clays, loams, and sands, of which the major part belong to the Lafayette formation.

Examples of the uneven dissolution of the underlying limestone are everywhere apparent. The St. Marks River, which is the principal stream in the southeastern part of the county, disappears underground and in a short distance surges again to the surface, thus forming the so-called Natural Bridge of that section. Similar examples of less importance are frequent. The numerous lakes, sinks, and connecting water courses of the county present many interesting local problems, inasmuch as most of them show clearly their direct relation to the underlying geologic structure. Owing to the light winter rainfall at the time of the survey, most of the sinks were dry, or nearly so, and the basal lime rock was either exposed or could be easily reached in numerous instances.

Three large lakes—Iamonia, Jackson, and Lafayette—are within the county, and a fourth, Miccosukee, lies along the northeast border. Subterranean passages, sometimes open, but usually closed or nearly so by débris, are a frequent concomitant of both these and the numerous smaller lakes. At times the water has entirely disappeared from Lakes Jackson and Iamonia, and then as the underground passage became closed they gradually filled again. During times of freshet the Ocklocknee River, which forms the entire western boundary of the county and receives the greater part of its drainage, overflows into Lake Iamonia through the "Upper Slough" until the water level of the lake equals that of the river. As the river falls the lake returns its abnormal volume of water to the river through the "Lower Slough." Susceptibility to overflow causes a large area of meadow along the sloughs between the lake and the river.

After the deposition of the Lafayette materials of red and yellow sands and clays, which give rise to the most important soils, the region was again depressed sufficiently to allow large areas in the southern part of the county to become submerged. This submergence also extended far up the stream courses to the northward until prevented by the closing in of the hills. From these waters were deposited the Columbia sands, which in the southern part of the county give rise to large areas of light sand. Farther north these sands, mingled with the finely comminuted material washed from the adjacent slopes, formed the sandy hammock land of the bottoms.

The forests of Leon County contain numerous species of trees and afford a large reserve of valuable timber. Extensive tracts of longleaf pine, interspersed with smaller areas of black-jack oak, still occupy the greater part of the county south of Tallahassee. In the northern part of the county longleaf pine, shortleaf pine, sweet gum, hickory, and several varieties of oak are common upland species, while the lowlands support a dense growth of black, yellow, and slash shortleaf pines, magnolia, bay, cypress, sour gum, sweet gum, water oak, beech, and willow, with scattering hickory, poplar, and tupelo gum.

SOILS.

The following table gives the names and areas of the several soil types established by this survey. A conspicuous feature of the types is the marked predominance of the sandy and sandy loam classes, there being only about one-half square mile of soil as heavy as loam or clay out of the 675 square miles land surface of the county.

Areas of different soils.

Soil.	Acres.	Per cent.
Norfolk sand	106,688	24.7
Orangeburg fine sandy loam	73,920	17.1
Norfolk fine sandy loam	67,328	15.5
Leon sand	61,376	14.2
Sandhill	42,752	9.8
Norfolk fine sand	28,608	6.7
Meadow	25,216	5.8
Leon fine sand	8,192	1.9
Orangeburg sand	6,912	1.7
Gadsden sandy loam	5,952	1.3
Swamp	2,816	.7
Gadsden sand	2,112	.6
Total	431,872	

ORANGEBURG FINE SANDY LOAM.

The surface soil of the Orangeburg fine sandy loam consists of brown, reddish, or yellow medium to fine sandy loam, from 4 to 15 inches deep. In different localities, however, the soil ranges from a heavy brown to a gray sand. The subsoil consists of red sandy clay to a depth of at least 36 inches and usually much deeper, but underlying cross-bedded sands are sometimes exposed at depths of from 5 to 10 feet. Iron concretions are a frequent occurrence with this type, and small gravel is occasionally found.

Many of the hollows of the Orangeburg fine sandy loam, which are so numerous as to constitute a very important part of the type, present heterogeneous variations. The soil is perhaps most often a dark-brown fine sandy loam for at least 10 inches and usually from 12 to 15 inches. This is underlain to a depth of from 20 to 24 inches by a layer of medium to fine yellowish sand or very light sandy loam of similar color. This material gives way to a dark-brown clay loam, which generally extends to a depth of at least 36 inches, but near the bases of slopes it is often displaced at 30 inches or below by the typical red sandy clay of the adjoining upland. Another common variation is sandy loam from 6 to 8 inches deep, underlain to a depth of 3 feet or more by successive layers of sand and sandy loam which range in thickness from 3 to 8 inches. Both of these variations and several local departures from the true type, small in area but similar in physiographic position, are characteristic features of the Orangeburg fine sandy loam of Leon County, occasioned by the rolling surface features of the type in conjunction with the tendency of this soil to wash in degree varying with the steepness of the slopes, which are an almost constant feature of the type. These quasi-bottom lands are an important consideration when speaking of the Orangeburg fine sandy loam, as they are generally quite productive, are considered superior to the true type in crop value, and are often planted, especially by the negroes, to the exclusion of the adjoining upland soils. So popular have these numerous though small areas been that they are usually designated by the indefinite but supposedly very desirable term upland hammock.

The Orangeburg fine sandy loam is the most extensive soil type in the northern two-thirds of the county. It occurs in areas of irregular outline varying in size from a few acres to many square miles. The largest and most continuous area of this soil is typically developed north of Lake Lafayette, extending westward from the road between Chaires and Miccosukee to the Tallahassee and Miccosukee road. Another area of considerable importance is found along the shore of Lake Miccosukee, extending north to the Georgia-Florida line and thence westward.

In the vicinity of the Iamonia-Thomasville road, near the north boundary of the county and adjoining Thomas County, Ga., the surface soil contains considerable amounts of finer grades of sand than is typical. This feature is most noticeable where the type adjoins the Norfolk fine sand, but it sometimes occurs where none of that type is near, or at least of sufficient area to appear on the map. Among the farmers there is no recognized difference in crop value between this fine phase and the rest of the type.

In topography the surface is rolling and the slopes gentle, except along a few of the streams, where valleys of considerable depth have been eroded. Sinkholes are numerous, and they have added to the irregularity of the landscape. There are no slopes, however, too steep to be cultivated. On account of the rolling character of the surface the natural drainage conditions are nearly perfect. The sandy character of the soil permits a large amount of water to be taken up during rains, and the subsoil is sufficiently impervious to prevent rapid leaching.

The Orangeburg fine sandy loam is derived from the sands and clays of the Lafayette deposition, which forms an almost continuous mantle over the northern part of Leon County.

The Orangeburg fine sandy loam, second of the soils in area, is the most important type in the area and the one most largely cultivated. It is generally recognized as the best upland cotton soil. The cotton is less subject to rust than on soils of the Norfolk series, and it grows later in the season. Under present methods of tillage the type is better adapted to cotton than to other crops, because the long tap root of the plant can penetrate the stiff subsoil better than the more fibrous roots of corn, cane, cereals, and potatoes, which, hindered in their downward course, are obliged to spread laterally along the surface of the stiff subsoil, and consequently shrivel at the approach of drought.

The Orangeburg fine sandy loam is considered poor for corn, because if plowed deep it "melts" and runs together after any heavy rain, then bakes hard, and the crop suffers. If thoroughly cultivated and kept open, it would produce good crops of any kind, but it is difficult to keep it in that condition, and so long as present methods of working obtain there is little possibility of efficient cultivation. With proper preparation and cultivation the Orangeburg fine sandy loam is probably one-fifth more productive than the Norfolk fine sandy loam, but as cotton, with its long tap root, is the only crop which can take advantage of this productivity under the prevailing methods, the Norfolk fine sandy loam with its more plastic subsoil is considered superior for all crops save cotton.

The Orangeburg fine sandy loam is naturally the best type of soil in the area for grain and forage crops, and by careful management in tillage, in the growing of legumes, and the judicious rotation of crops its productiveness could be largely increased. Filler tobacco has been grown satisfactorily in a limited way on this type, and it should prove a suitable soil for this purpose. It does not produce as good a quality of Sumatra wrappers, however, as soils of the Norfolk series.

The average yield of cotton without fertilizer on this type is about one-third bale per acre. Well farmed an average of one-half bale is readily obtained, and intensive methods would make 1 bale per acre easily possible in favorable seasons. Corn yields from 8 to 15 bushels, depending largely on the way it is worked, and oats 10 to 20 bushels per acre. Little sirup is produced on this type, as it is inferior in both quality and quantity to that obtained from soils of the Norfolk series and the Gadsden sandy loam.

The subjoined table shows the average results of mechanical analyses of samples of both soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
12758, 12760	Soil	0.4	8.9	12.3	42.5	17.3	5.5	12.6
12759, 12761	Sobsoil	.3	4.3	7.6	33.1	13.2	5.7	35.4

ORANGEBURG SAND.

The surface soil of the Orangeburg sand consists of medium to fine gray or reddish-brown sand which in places is sufficiently loamy to be classed as a light sandy loam. This material, which usually contains some iron concretions, ranges in depth from 6 to 10 inches, and is underlain by a reddish-yellow sandy subsoil which becomes somewhat sticky before giving way to the typical red sandy clay of the Orangeburg series. This change of subsoil takes place between 15 and 36 inches, but the average depth is about 2 feet.

The Orangeburg sand occurs only in a few small isolated areas, where it is associated with the Orangeburg fine sandy loam or the Norfolk sand, usually forming a transitional soil between those types. Occasionally a small area lies within the Orangeburg fine sandy loam, occupying a slight elevation which has not suffered from erosion, and again occurs on a long, gentle slope from the Orangeburg fine sandy loam to a stream course or its adjoining strip of meadow. On account of its topographic position and the depth of clay below the surface the Orangeburg sand is well drained and also suffers more from drought than the Orangeburg fine sandy loam.

The Orangeburg sand is derived from the Lafayette formation, but in some cases the surface soil has been modified somewhat by surface washings from Norfolk sand or Orangeburg fine sandy loam.

This soil is not as well adapted to general farming purposes as the Orangeburg fine sandy loam, because the more porous nature of the soil and the greater distance of the clay below the surface renders it more susceptible to drought and less retentive of plant food. In the one instance in which wrapper leaf tobacco has been grown under shade on this type the leaf was of excellent quality, and the yield without irrigation in a season abnormally dry was 700 pounds per acre.

Most of the type is used for general farming and is fairly well adapted to this purpose. Cotton yields from one-fourth to one-third bale per acre and corn from 8 to 12 bushels. The yields of all crops are usually a little below those of the Orangeburg fine sandy loam.

The following table shows the results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Orangeburg sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
12754	Soil	0.4	9.2	17.5	52.3	11.7	2.9	6.2
12755	Subsoil	.3	7.9	16.7	43.2	8.5	2.9	20.4

NORFOLK SAND.

The surface soil of the Norfolk sand of Leon County consists of gray, yellow, or light-brown sand of coarse, medium, and fine grades, underlain to a depth of 36 inches or more by light-gray or yellow sand of similar texture. Near boundaries with heavier types this soil is sometimes underlain by clay loam or sandy clay at depths below 30 inches. The varied surface appearance of the type is due largely to the methods of cultivation which have obtained upon it. Where not tilled for a considerable period and where not burned over in recent years the soil has a dark loamy appearance, due to the accumulation of organic matter, but where farmed exhaustively or subjected to frequent burnings this characteristic is soon lost and the soil has a light-gray or whitish appearance. The marked difference in this soil which the presence of large amounts of organic matter produces is vividly shown by various fields in the county, which, having been benefited by heavy fertilization, appear in striking contrast to the surrounding type. In section 1, about 1½ miles southwest of Lake Jackson station, the sand is of coarser grades than usual and contains considerable fine gravel, thus rendering it less productive than the normal type.

The Norfolk sand is the most widely distributed soil in the area surveyed. In the western part of the county it occurs as a long strip of irregular width along the bluffs back from the Ocklocknee River, extending from Ward northeast nearly to the Georgia line. In the southern part of the county a band ranging in width from one-half mile to 4 miles extends from near Springhill eastward for 15 miles, gradually widens as it turns northward toward Chaires, and terminates but a short distance south of Miccosukee in the northeastern part of the county. Numerous smaller areas are found in various parts of the county.

The type is generally level or but slightly rolling within itself, though it may occur as river bluffs, bottom lands, or large upland areas.

The principal part of the Norfolk sand is well drained. Only small areas have deficient drainage, due to their relation to streams or low, swampy areas. The soil is so open and porous that it becomes droughty much sooner than the types with heavier subsoils.

In the northern part of the county this soil on the uplands is derived from the sands of the Lafayette mantle, while in some of the lowlands and in the southern part of the county it is derived from the Columbia sands.

The Norfolk sand is too light for the best results with general farming, but fair yields can be secured if well managed by following a regular crop rotation which includes one or more leguminous crops. For this purpose velvet beans have been the most successful, particularly in the southern part of the county.

On the few spots which are "cow-penned" sweet potatoes yield from 50 to 100 bushels the first year, sirup 10 to 20 barrels the second year, and corn 15 to 20 bushels the third year, after which time corn yields from 8 to 10 bushels per acre without fertilizer when rested in alternate years. Where the land is not "cow-penned" at all the yields are low, the land is generally rested every other year, and large areas are not farmed at all.

The little cotton grown yields from one-sixth to one-fourth bale per acre. Last year one farmer grew 1,415 pounds net of long-staple seed cotton which gave 446 pounds of lint from 2½ acres. As this is as large a yield as is obtained from short-staple cotton on the same field, and as the product brings a much higher price, the opportunity for extending the production of long-staple cotton on the Norfolk sand and Norfolk fine sand seems very favorable. The fact that about twice as much labor is required to pick the long-staple cotton, however, undoubtedly deters many from engaging in its production.

The following table shows the average results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Norfolk sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
12730, 12732	Soil	0.8	8.1	9.7	49.5	21.2	6.4	3.7
12731, 12733	Subsoil	.6	9.1	10.2	47.5	23.0	5.6	3.6

NORFOLK FINE SANDY LOAM.

The surface soil of the Norfolk fine sandy loam in its typical development consists of a grayish or light-brown fine sandy loam, but in different localities it includes a range from light loamy sand to heavy sandy loam. This material, which has an average depth of 8 inches, gives way to a yellow sandy loam, which in turn is underlain at depths ranging from 12 to 30 inches by a yellow sandy clay or clay loam. In the vicinity of Tallahassee and for 3 or 4 miles north of that city the subsoil of this type is frequently reddish yellow in color, and there represents a gradation between the Norfolk fine sandy loam and the Orangeburg fine sandy loam. In such cases the Norfolk fine sandy loam was mapped to include the variation. Along the north side of Lake Iamonia the surface soil of this type consists of finer grades of sand than is typical. The soil is often loamy, but in small areas it is very loose and consists of brown or yellowish fine sand. The subsoil is a plastic drab-colored clay loam. Small areas of similar surface soil occur north of Iamonia near the line with Thomas County, Ga. The most typical development of the Norfolk fine sandy loam occurs in an irregular and broken area which extends from east to west through Centerville and Bradfordville. In all of the northern two-thirds of the county, however, the type is of frequent occurrence and is second in importance only to the Orangeburg fine sandy loam, with which and the Norfolk sand it is usually associated.

The topographic features of the Norfolk fine sandy loam include many broad slopes, low hills, and intervening valleys incident to a gently or moderately rolling country. These physiographic fluctuations are seldom so strongly marked as with the Orangeburg fine sandy loam, and this characteristic gives to the type a much smoother general appearance.

Drainage is generally well established on this soil, but some of the upland areas are so flat that water collects in small pools, which become dry only at the approach of drought. The type undoubtedly retains a greater water supply available for general farm crops than any other soil in the area. This is largely because its clay subsoil is more plastic in its nature than the red clay, and plant roots can penetrate it much more readily, thus gaining access to a larger supply of moisture.

The Norfolk fine sandy loam is derived in part from the Lafayette mantle, to some extent from later sedimentary deposits, and to a slight extent from a reworking of both these materials.

The soil is adapted to the production of corn, cotton, oats, rye, sweet potatoes, and forage crops. In Gadsden County this type is also considered a satisfactory soil for the production of wrapper tobacco[a] and would undoubtedly prove no less desirable here. Corn yields, if well cultivated, 15 bushels per acre without fertilizer, and if manured a yield of 25 bushels per acre may be obtained. So much of the type receives no fertilizer, however, and in addition is so poorly cultivated that from 10 to 12 bushels is an average yield. Cotton yields from one-fourth to one-third bale per acre. The sirup produced on this soil is superior in flavor and color and greater in quantity than that obtained from the Orangeburg fine sandy loam.

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[a] Soil Survey of Gadsden County, Fla., Report of Field Operations, Bureau of Soils, U. S. Dept. Agr., 1903, p. 333.

The following table gives the average results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
12744, 12750	Soil	0.3	5.0	10.5	52.6	14.3	7.4	9.8
12745, 12751	Subsoil	.2	3.1	5.8	38.6	15.3	4.6	32.2

GADSDEN SANDY LOAM.

The surface soil of the Gadsden sandy loam consists of brown sandy loam from 8 to 14 inches deep, underlain by grayish-yellow or yellow sand or light sandy loam to a depth of 3 feet or more. The content of the coarse and fine grades of sand is such as to give the effect of a medium sandy loam, although the content of medium sand is relatively low. In small areas, however, coarse sand is present in sufficient quantities to constitute a coarse sandy loam. The surface soil is very similar to some of the Norfolk fine sandy loam, but the subsoil is dissimilar in that the underlying sandy clay of that type is entirely wanting or is found only in spots at a depth of nearly 3 feet below the surface.

The Gadsden sandy loam is found in small areas closely associated with the Norfolk fine sandy loam and the Norfolk sand.

The topographic features of the type are diversified. The upland areas are usually flat hilltops or small tablelands, but the type frequently occurs along streams elevated just above the meadow land, where such exists, or in shallow, well-drained depressions about small stream heads, and again it occupies gentle slopes between the upland and stream courses or the meadow adjoining them.

In a few small depressions or on gentle slopes along lake shores the soil, as well as subsoil, is of a rather heavier texture than is the case in the main areas of the type.

Drainage is generally well established, though in areas unimportant because of their small size it is sometimes deficient near streams or meadow areas.

In elevated positions the type is derived from the sandy materials of the Lafayette formation, but on slopes and in lower lying areas it represents colluvial material, which in a few cases immediately along streams has been reworked with the Columbia sands.

Most of the Gadsden sandy loam is farmed, and it is markedly superior to the Norfolk sand in productivity and still is an easy soil to work.

Cotton and corn give good returns, and in the lowlands sugar cane brings a good yield of sirup of excellent quality. Where the physiographic position is suitable the type is well adapted to the growth of Sumatra wrappers under shade.

The following table shows the average results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Gadsden sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
12770, 12772, 12776, 12778	Soil	0.9	13.1	14.1	40.9	11.4	5.6	13.8
12771, 12773, 12777, 12779	Subsoil	.7	12.1	15.1	42.1	10.7	4.8	14.3

NORFOLK FINE SAND.

The surface soil of the Norfolk fine sand consists of fine brown or dark-gray loamy sand from 6 to 14 inches deep. This material is loose and friable when dry, but packs slightly when wet. The subsoil consists of fine-grained pale-yellow or light-brown sand. An important area of the Norfolk fine sand is found in the northwestern part of the county between Lake Jackson and the Ocklocknee River, where a long and narrow area is separated from the overflow land along the river by a strip of Norfolk sand. In the southeastern part of the county the most typical development of the type is in the vicinity of Woodville. There the surface soil is the most loamy of any of the type in the southern part of the county, and this characteristic holds for a considerable distance toward the east. With increasing distance from Woodville, however, the content of organic matter steadily, though almost imperceptibly, diminishes until it is replaced on the east by the Leon fine sand, which is very deficient in organic material, and on the west, where the texture becomes coarser, by the Norfolk sand. Small areas are found along the shores of Lake Iamonia, and areas too small to be indicated on the map are not infrequent in the northern part of the county along lakes and also occupying the bases of slopes. Near the county line, north of Iamonia, the Norfolk fine sand is generally level, and occasional low, rolling hills and minor elevations constitute the only variation in its topographic features.

The natural drainage conditions of the type are such that it seldom suffers from too much moisture, yet it can withstand drought better than the Norfolk sand. Occasional small, low-lying areas, however, where adjacent to the Leon sand, small lakes, or sink holes, or in depressions along minor streams suffer somewhat from deficient drainage in wet seasons, and their crop value is correspondingly impaired.

The Norfolk fine sand is derived from the sedimentary deposits of the Gulf Coastal Plain.

In the northwestern part of the county and in the vicinity of Woodville the Norfolk fine sand is used to some extent for general farming, and cotton, corn, potatoes, and forage crops all bring good returns when well farmed. Most of the type in the southern part of the county, however, is still covered with the native forest growth, and little advance is being made toward extending its cultivation, though it is the best soil there, and should prove a fairly satisfactory soil for the general farm crops grown. Velvet beans seem to be the most successful leguminous crop which has been tried, and should be used as one member of a regular crop rotation. The soil is well adapted to early garden crops, but market limitations preclude at present the possibility of engaging profitably in this industry.

In the northwestern part of the county this soil without fertilizer brings an average yield of 10 bushels of corn per acre. Fertilized with stable manure cotton yields one-half bale per acre, and oats, following a leguminous crop without other fertilization, yields 15 bushels per acre.

The Norfolk fine sand, where the physiographic conditions are suitable, is exceptionally well adapted to the production of wrapper-leaf tobacco. In the area near Lake Jackson, where the soil is typically developed, shade-grown leaf of excellent quality is produced. The leaf is fine in texture, thin, and elastic, and burns well. For the extension of the wrapper-leaf industry this type undoubtedly presents remarkable opportunities.

The following table shows the average results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
12736, 12742	Soil	0.4	4.1	5.0	59.8	19.2	5.4	5.5
12737, 12743	Subsoil	.3	3.4	4.6	51.6	30.0	4.4	5.3

SANDHILL.

The surface soil of the Sandhill consists of coarse to medium loose yellow or white sand to an average depth of 6 inches. The subsoil consists of yellow sand which is generally similar to the soil in texture, but in places the proportion of coarse sand is greater and small amounts of fine gravel are present. The soil seldom contains an appreciable content of organic matter.

The principal Sandhill area begins a little more than 2 miles south of Tallahassee and extends east and west in a broad band until cut off on the east by Norfolk sand and on the west by the same type, which there, however, seems a gradation soil to the large area of Leon sand, the chief type in the southwestern part of the county. Many smaller areas are associated with the Norfolk sand in the southern part of the county.

The topographic features of the type consist of low ridges, knolls, and swells, which give a somewhat rolling aspect to the principal area. The smaller areas are always hills or ridges surrounded by the Norfolk sand.

The Sandhill is derived from sands laid down as coastal deposits.

Both surface drainage and subdrainage are so excessive on account of the loose and porous character of the soil to a depth of many feet that it is not worth while to try to produce farm crops upon this type. Stunted pine and scrub oak are the natural forest growth. In spots the soil supports a sparse growth of wire grass, but over much of the area this appears only in tufts from 1 to 3 feet apart. The appearance of this type is dreary in the extreme, and it is practically worthless for agricultural purposes.

The following table shows the results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Sandhill.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
12774	Soil	0.2	8.6	24.5	51.9	11.1	1.1	2.3
12775	Subsoil	Tr.	9.3	25.8	49.7	11.4	1.0	2.4

LEON SAND.

The surface soil of the Leon sand consists of from 6 to 10 inches of gray or white medium sand, occasionally containing sufficient organic matter to give to it a dark-gray color. The surface soil is usually moist and often very wet and inclines toward compactness. The subsoil is a pure white compact medium sand saturated with water, or nearly so, or sand of the same texture but colored light-brown, with similar water content.

The Leon sand occurs in one large area in the southwestern part of the county, its extreme dimensions being 9½ by 16 miles. There is also a small area between Ocklocknee and Lake Jackson.

The topographic features of the Leon sand are typical of the flatwoods country. In general the surface is very level, but it is marked in places by two sorts of elevations—long, low swells seldom exceeding a height of 3 feet above their surroundings, and small knolls, generally circular or elliptical in shape, but of similar height. The latter range in size from the fraction of an acre to 10 acres, but the average is less than 3 acres. Such areas are slightly more loamy than the true type, are similar to poor areas of the Norfolk sand, and would have been mapped as that type had they been of sufficient extent. The entire soil type is marked by bay galls, many of which are but a few rods across, while others contain several acres. The frequency of these galls varies greatly, for in places several of them may be found in an acre, while again there are but 1 or 2 on a square mile. Precisely the same in character, but much larger in extent, are several swamps, of which the largest is Grand Bay.

The Leon sand is so level that the drainage is everywhere deficient, and water collects in the numerous bay galls. In a season of drought these galls are dry and the surrounding soil is no longer saturated, but at every heavy fall of rain the galls are filled, and if the rain is of long duration a series of them are connected by a stream which generally flows into the larger water courses emanating from the swamps. Drainage conditions so defective render the soil worthless for agricultural purposes.

The Leon sand is derived from the beds of sand drift which overlie the basal limestone, but they never have the bright red or yellow colors of the stratified drift north of Tallahassee, and in places these sands have been slightly reworked at the surface by shifting waters.

The Leon sand is not adapted to any farm crops under present agricultural conditions, and but for its timber growth would present a vast monotonous waste. It is covered, however, with extensive open forests of longleaf pine, which yield a considerable income even with the present inefficient and wasteful methods of gathering the pitch for turpentine distilling. The longleaf pine grows luxuriantly upon this soil, and the entire area should be devoted to its production. Under intelligent forestry management excellent opportunity is here presented for long-term investments. The soil can be bought at prices ranging from 75 cents to $2 per acre, but a forestry venture would require personal supervision to keep trespassers from cutting the timber or cupping it for turpentine.

The natural undergrowth in these open forests is wire grass and dwarf palmetto, and formerly large herds of cattle were maintained here on open range, but the advent and extension of the turpentine industry over nearly the whole district has so injured the grazing that many more cattle are lost now than several years ago and the number kept is rapidly decreasing.

The following table shows the results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Leon sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
12766	Soil	0.8	18.3	16.5	37.5	19.7	5.2	1.5
12767	Subsoil	.8	15.0	16.2	37.8	21.3	5.6	3.1

LEON FINE SAND.

The Leon fine sand is a light-gray to white fine sand, usually underlain at 12 inches by a white fine sand extending to a depth of 36 inches.

The type is found in the southeastern part of the county, extending for several miles along both sides of St. Marks River. These areas vary from one-half to 2 miles in width. Two other smaller areas occur also in that part of the county.

The type is closely related to the Leon sand, the only essential difference being in the texture of the sand composing them. It has an almost level surface, and the natural drainage conditions are poor. It supports for the most part a growth of longleaf pine. Under present conditions the type is valuable only for its scattered timber growth and scant pasturage. Practically no farm crops are grown upon it.

The following table gives the average results of mechanical analyses of the Leon fine sand.

Mechanical analyses of Leon fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
12768	Soil	Tr.	2.2	2.9	58.7	33.6	1.9	0.6
12769	Subsoil	.1	2.0	2.7	58.5	33.9	1.9	.7

GADSDEN SAND.

The surface soil of the Gadsden sand consists of black, brown, or dark-gray loamy fine sand, containing usually a large amount of organic matter. The subsoil is a gray, drab, white, or yellow fine sand, underlain usually at from 2 to 4 feet by a compact stratum of sand.

The type occupies small areas east of Lake Lafayette in the vicinity of Chaires and a few other scattering small areas. It also has a limited occurrence along the shores of Lake Jackson and near-by low-lying areas.

The soil occurs principally as level or slightly-depressed areas along the lake or stream courses, but is also found to a limited extent in isolated depressions which at some previous time have been swampy. To this former swampy condition is due the accumulation of organic matter. This condition is still exhibited in some places which are not yet completely drained by surface ditches.

The Gadsden sand is probably derived from the Columbia sands upon which organic matter has accumulated because of deficient drainage. In some of the areas the soil is composed principally of colluvial material.

Where drainage is sufficiently established, the type is moderately well adapted to the production of corn and forage crops. In some areas cabbage and onions are successfully grown on this character of soil, and in others cotton and sugar cane would do well in favorable seasons.

The following table shows the average results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Gadsden sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
12728, 12762	Soil	0.7	7.8	7.7	48.0	19.4	9.2	6.9
12729, 12763	Subsoil	.8	7.0	8.3	48.6	22.4	6.1	6.5

SWAMP.

The term Swamp has been applied in this area to low-lying lands which are submerged for the greater part of the time. In the winter and after heavy rains at other seasons the water is waist deep over much of their area, and occasional holes are much deeper. In the summer these swamps often become dry enough so that one may travel about them readily, but after any extended rain this is impossible. The principal areas of this kind are associated with the Leon sand in the flatwoods country. The swamps are filled with a dense growth of bay, cypress, sour gum, and water-loving shrubs, and from the prevalence of the bay growth are called "bay swamps" or simply "bays." The most extensive occurrence of this kind lies southeast of Bloxham and is known as Grand Bay. Most of the streams in the southern part of the county have their source in these bays. At present such areas are of no value except for the timber which some of them contain, and as drainage would be generally impracticable or impossible it is not likely that any attempts of this kind will be made.

MEADOW.

Adjoining many of the streams of the county are low-lying, narrow, flat, poorly-drained areas of variable soil texture. As these areas are subject to overflow, they have been mapped as Meadow. Along the Ocklocknee River the fringe of overflowed land varies greatly in width. Steep bluffs sometimes extend along the river for a short distance, but they soon recede and are replaced by a low, narrow, flat area of Meadow, which increases in breadth until it is sometimes more than a mile wide. In the highest freshets this is all subject to overflow. The surface, although nearly flat, is cut by numerous bayous, small streams, and minor depressions or deep holes, all of which contain water most of the year. The soil is very diverse. It is most often, perhaps, a medium or fine sand or light sandy loam. This sand covering varies greatly in depth in short distances, but the average depth is about 12 inches. Frequently it is entirely absent and it seldom exceeds a depth of 15 inches, except in the northern part of the area, where in places it attains a depth of 3 feet.

When the sandy covering is lacking, the surface soil consists of extremely stiff, heavy clay, drab, light gray, nearly white, or light brown in color. The subsoil consists of a very heavy stiff clay similar in color to the soil. Where the sandy surface soil is present, it overlies the characteristic subsoil just described.

The low, nearly flat topography of the Ocklocknee Meadow, in conjunction with its extreme imperviousness to moisture, thereby preventing any downward drainage, its position along a river which leaves its banks at every extended rain, renders these areas unsafe and so impracticable for the purposes of cultivation that no attempt was made to classify them. The natural forest growth which covers them includes black, yellow, and slash shortleaf pines, bay, cypress, sour gum, sweet gum, water oak, beech willow, poplar, with scattering hickory and tupelo gum. This luxuriant growth affords a valuable timber supply which with conservative management will last for a good many years.

At each end of a small pond, located nearly a mile west of Tallahassee, occur two small areas of Meadow, one of which was artificially drained and sown to rice two years ago, but the yield was unsatisfactory. Here the soil, with an average depth of 12 inches, consists of black mucky loam or clay loam, grading into a gray sandy clay which is in turn underlain at 24 inches by a heavy plastic drab-colored clay. With drainage conditions well established both these areas would be adapted to the production of corn, cane, and all forage crops.

In the southern part of the county large numbers of hogs and some cattle are maintained in the Ocklocknee Meadows, but a different stock law in the northern part of the county requires the maintenance of fences, and so the pasturage is not of economic avail.

AGRICULTURAL METHODS.

Land in Leon county has been so abundant and cheap on account of the scarcity of white farmers that it has generally been found easy to get a living under the system of agricultural practice handed down by preceding generations. For this reason and from the fact that a large proportion of the land is worked under the tenant system by negroes, who are apt to consider only one year at a time and are usually unconcerned as to the condition of the land at the end of the season, there has been little incentive to steady improvement of farming methods. Progressive farmers are occasionally found, however, and they, by improving their methods of cultivation and paying more attention to the rotation of crops, may well be considered as pioneers in a new and more intensive system of agriculture. Such men use two-horse plows, disk harrows, mowing machines, and other improved implements.

The sandy nature of most of the surface soil of Leon County renders it easy to plow and easy to cultivate throughout the growing season. A large part of the land is plowed with a one-horse plow to an average depth of 4 inches, and the furrow slices are so laid as to form a double furrow bed between the rows of the preceding season. Fertilizer is then dropped by hand through a fertilizer tube and covered with a little soil. The seed is then dropped either by hand or with a one-horse planter and covered with a scooter. Fortunately two-horse plows are now coming into use, especially in the northern part of the county. Where these are used, the land is plowed to a depth of 5 or 6 inches and the bedding is done afterwards with a single plow.

Corn, which is usually cultivated three times, is worked first with a single plow, then with a small sweep, and again with a plow which gives a little elevation to the bed. Any additional working is done with a sweep. Cotton is worked from three to six times, chopped once, and usually hoed twice. The high hilling, which is an almost universal practice in the area, leaves the crops much more susceptible to the effects of drought than would more level culture.

Tobacco is cultivated nearly every week until large enough to be liable to injury from the breaking of the leaves.

The climatic conditions of the county are not sufficiently tropical for sugar cane to mature its seed, and it is propagated by planting cuttings of the stalks.

The census of 1900 gives the percentage of farms operated by tenants as 81.4, and these farms are planted almost exclusively to cotton, with some corn and occasional patches of sugar cane and sweet potatoes. As the three latter crops are usually planted on particular locations, even the relatively small opportunity for crop rotation which these crops might be expected to furnish is lost, and cotton succeeds cotton year after year. The average colored farmer on a one-mule farm of 40 acres plants about 25 acres in cotton and 15 acres in corn. When a field becomes worn out by such a method of procedure, the tenant seeks to rent other land which he hopes is not so exhausted, while the landlord finds another tenant or the land is thrown temporarily out of cultivation.

Labor conditions are such, however, that in spite of the exhaustion of the land there is a gradually growing tendency for the white farmers to continue this policy and leave most of the cotton growing to negroes under the tenant system, while their own attention is devoted to other branches of farming. In this way only a very small percentage of the cotton land is fertilized at all, and when it is recalled that the land is also deprived of the benefits of crop rotation the wonder is not that the average county yield is only one-fourth bale per acre, as given in the 1900 census, but rather that a sufficient crop is produced to afford sustenance to the growers.

Many of the white farmers, however, practice some form of crop rotation. In some cases land has become so unproductive by constant cropping with corn that the yield of that grain has been increased from 8 to 15 bushels per acre simply by resting one-third of the land each year. A common practice among the best farmers is to follow corn with oats and cowpeas the same season. After the peas are harvested, the field is pastured for the rest of that season and the next on the crab-grass, crow-foot, and beggar-weed which come in. If left another season, it becomes overrun again with broom-sedge, which, in some unfortunate cases, is burned, thus destroying the humus which otherwise might accumulate. Corn may follow the fourth year or it may be preceded by cotton for one or two years, and small fields are sometimes planted to peanuts after the second year of pasturing. Sometimes only a part of the oats and cowpeas is cut for hay and the rest is pastured. The use of velvet beans is growing, and they are very successful here, but they are not popular because of the difficulty in saving the seed.

A common so-called rotation is cotton two or three years, followed by corn for the same number of seasons. Part of the area is then sown in oats and the rest in cowpeas, which are generally sown in the corn. A part of the peas are cut for hay and the rest left to improve the soil. Some land has been so exhausted that peas do not grow well. In such cases resort is sometimes had to the velvet bean, which will grow where peas fail.

Some of the best farmers apply commercial fertilizer to cotton at a rate of from 100 to 500 pounds per acre. An average price for this fertilizer is $22 per ton. Tobacco grown under shade is highly fertilized at the rate of 1½ tons of cotton-seed meal or 100 bushels of cotton seed and 800 pounds of sulphate of potash per acre.

At least one dairyman has demonstrated conclusively the feasibility of adopting a definite system of crop rotation which is entirely practicable and suited to the needs of dairymen in the county. From April until June some pasturage is afforded by the natural grasses. To supplement this for that period oats are mowed green. From June until October cowpeas are mowed and fed green. Variety is afforded during a part of this period by fodder corn, which is available from June until August. From October 1 velvet beans are used from two to four months. An underground silo furnishes corn ensilage from October until May 1 and variety is again given from December until April by pasturing fields of oats and rye mixed.

Hogs—a Poland China cross on razorbacks, which gives a good general-purpose hog for this climate—are an important by-product under this system. Pigs farrowed between January and March are pastured in the spring on oats and rye mixed, and in addition are fed plenty of skimmed milk, a little corn, and Japan cane which has been banked the preceding fall. This is followed by sorghum, green fodder corn, and peavines until October, when sweet potatoes are ready. These are followed with peanuts, which are usually replaced with corn from two to three weeks before killing to give firmness to the flesh.

A case such as just cited should afford sufficient incentive to surrounding farmers to adopt methods of farming whereby the fertility of their land may be not only maintained but largely increased. Many are not so situated or so trained that they could engage in the dairy business successfully, but there is no reason why everyone can not practice a suitable rotation on part of his land by growing at least enough leguminous crops each year to furnish the roughage needed for stock. Of crops suitable for this purpose beggar-weed is perhaps the easiest grown, but the velvet bean grows vigorously in several parts of the county. The cowpea, which has been the most extensively grown, has failed in some places, and it is thought to be due to the lack of the bacteria which form the root tubercles. The experiment of introducing cultures of nitrogen-fixing bacteria furnished by this Department is being tried in the county this year and much hope in the results is entertained.

AGRICULTURAL CONDITIONS.

Leon County presents the general aspect of undeveloped possibilities. A climate remarkably open and mild and soils so susceptible to improvement that good crops can be easily and cheaply obtained, although the agricultural methods in general use are far out of date, furnish abundant opportunity for those who will properly develop their farming interests. The marked success of the enterprising few gives unmistakable proof of this.

The tenure of farms varies greatly in different parts of the county. From Bradfordville north probably 65 per cent of the owners live on and till their own farms. The rest of the cultivated land is leased to negroes in one and two mule farms (40 to 80 acres), the rental paid ranging from 400 to 700 pounds of lint cotton. On the excellent strip of soil which lies between Bradfordville and Tallahassee, extending nearly across the county from east to west, not over 15 per cent of the landowners live on and till their own farms. This land was formerly held in very large tracts, but much of it has now been divided into smaller holdings and is rented to negroes, while 80 per cent of the owners live in Tallahassee, Fla., and Thomasville, Ga., and about 5 per cent in northern cities. In the southern part of the county 95 per cent of the white people live on and till their own farms and 5 per cent is owned by negroes. The principal part of the land in the southern part of the county, however, is not farmed at all, and large tracts, comprising from 1,000 to 10,000 acres or more, are owned by men engaged in the lumber or turpentine business.

The census of 1900 gives the average size of farms in Leon County as 85.4 acres, but they range from 40 to 1,100 acres or more (not including the larger bodies owned by nonresidents), and most of the white farmers own from 100 to 400 acres, with a probable average of 200 acres.

Notwithstanding the large negro population, from which most of the farm hands are drawn, it is very difficult to hire sufficient labor. There are several causes which contribute to this condition. Farmers have held that they could not afford to pay more than 50 cents per day for labor, though in some parts of the county the wage has now been raised to 75 cents per day. This is because the railroads, sawmills, and turpentine camps pay $1, $1.25, and in exceptional cases $1.50 per day for labor, and so control the situation. Turpentine cupping and gathering in the southern part of the county has been a popular occupation, inasmuch as the cupping is done at a stated rate per box, usually 1½ cents, and the laborer can take time off when he chooses. In the northern part of the county farm labor is more plentiful than elsewhere. There the price of day-labor is 40 to 60 cents for men and 25 to 50 cents for women. Men who work by the month are paid from $8 to $10 and board, usually for a term of six to seven months, but occasionally by the year. Plow-boys receive from $5 to $7 per month for six months, and after their time expires they pick cotton, "pull" fodder, etc., by the day. The most serious phase of the labor question is curtailment of cultivation, for the reason that the farmers feel they can not afford to pay labor the price offered by other industries.

The character of the principal agricultural products varies widely in different parts of the county. In the central part of the area short-staple cotton is the crop of most importance, as the tenants grow barely enough potatoes and cane and not more than two-thirds enough corn for their own use, while a hog or two and a cow are the only live stock kept on the small tenant farms. In the southern part of the county the products are corn, sirup, oats, sweet potatoes, watermelons, and cantaloupes. Near the Ocklocknee River hogs and beef precede these products in importance and considerable honey is made.

In the northern part of the county cotton growing has been displaced to a considerable extent by general farming. Corn is the principal crop, and it is sold for cash, fed to beef cattle, and used for working stock in about equal parts. Grade Durham cattle are used for beef purposes, and Jerseys, with a few Guernseys, for butter. Butter is the leading product with a few farmers, and in that case pork is an important product. Two grades of oats are grown. If sown in November or December, the product weighs about 32 pounds per bushel, while if sown in February or March from 24 to 28 pounds per bushel. About 60 per cent of the crop is sold in Florida markets, and the remainder is used at home. Of the large quantities of peanuts grown a few are sold in the local markets, but most of them are fed to hogs.

Much of the beef produced in the county is mediocre. The range cattle no longer thrive, but are small and poor. Cows too old to be profitable for milking also find their way to the local beef market. Some good beef is obtained, however, from young fattened steers.

Crab-grass and pea-vine hay are sold in sufficient quantities to supply the small local markets. Orchards of Le Conte pears are frequently seen, but most of them are infested with disease and generally neglected, as it is thought they can not be grown at a profit under present market and shipping conditions. Peaches and figs both thrive and many residents grow enough for their own use.

Sugar cane grows luxuriantly on many of the soils, and many farmers have some sirup to sell after supplying their own needs. The market for the sirup is so limited, however, that at present there is little encouragement to increase production. The excellent quality of sirup produced and the larger areas of soil suited to its growth should be sufficient incentive to establish the industry on a commercial scale.

The number of pecan trees in the county is given by the census of 1900 as 2,561. Many of these are scattered in dooryards, but there are a few small orchards. The trees are thrifty and productive for a term of years sufficiently long to give much promise for the development of this industry. The Orangeburg fine sandy loam, where the red sandy clay is at least 12 inches below the surface and not very stiff until a depth of at least 3 feet is reached, is probably the best soil type for this nut. Where the subsoil of the Orangeburg fine sandy loam is too stiff, well-drained Norfolk fine sandy loam is better for pecan growing.

Sea Island cotton, which has been successfully and profitably grown in a limited way on the deep sandy soils in the southern part of the county, gives promise for increased acreage.

The growing of Sumatra wrapper-leaf tobacco under shade is a success in Leon County, and there is enough land suited to its production to allow the industry to be largely extended. For the average farmer, however, there are several difficulties to contend with in growing this grade of leaf. The cost of erecting the shades and curing sheds is heavy, great care must be exercised in handling and curing the crop, small individual lots can not be assorted into the proper grades, and large areas require more capital than most farmers have. These conditions are sufficient to deter the average farmer from engaging in the business, but for the small grower the uncertainty of disposing of his crop for a satisfactory price, because he must take whatever is offered to him by controlling buyers, is even more serious. If the market were open to the small growers, or if they could combine their crops in assorting and in sale, they might then, with large lots of a more uniform product, be able to dispose of their crop to better advantage. Of the success of the large growers who are sure of a satisfactory market, there can be little question, and the industry offers excellent opportunities for extension on a large scale.

Small areas of Sumatra tobacco grown in the open field yield about 1,000 pounds per acre, bringing an average price of 20 cents a pound. Cuban filler leaf, grown in a small way, yields about 600 pounds per acre, and the average price is 15 cents per pound. An excellent quality of leaf is produced on the Orangeburg fine sandy loam, and this type, with the reddish-yellow areas of Norfolk fine sandy loam, probably offers the best opportunities for developing this industry.

The adaptation of soils to crops is recognized only in a very general way. The saying is common that the red clay of the Orangeburg soils is best for cotton, but that the yellow clay, by which is meant nearly all other upland types, is better for other crops. Bottom lands of all types are sought for corn and cane, but avoided for cotton, as the growth of stalk is too rank and it does not fruit well. Sea Island cotton is always grown on deep, sandy soils, as it is recognized that it does not do well on the clay subsoils. The Orangeburg fine sandy loam is avoided for cane, as it produces a darker-colored sirup than the Norfolk and associated soils.

Transportation facilities in the northern part of the county are very inadequate, as large areas are more than 10 miles from a station. The Seaboard Air Line Railway, connecting Jacksonville and Pensacola, crosses the county from east to west. The St. Marks branch of the same road, and the Carrabelle, Tallahassee, and Georgia Railroad connect Tallahassee with the Gulf; the Tallahassee and Southeastern goes to Gainesville and South Florida; and the Georgia, Florida, and Alabama Railway connects Tallahassee, via Bainbridge, Ga., with the north. The freight rates are said to be generally high and the roads not to afford the outlet for products that they should.

Tallahassee is the principal market for the central and southeastern parts of the county. In the northern part much of the cotton is sold at Metcalf or Cairo, Ga., sirup at Tallahassee, and tobacco at Quincy. The latter town is also the principal market for the southwestern part of the county. Cattle are often bought by drovers, who drive them to southern Florida markets or ship them from Tampa to Cuba.

SOIL SURVEY OF LAUDERDALE COUNTY, ALABAMA.

By **F. E. BONSTEEL, ORLA L. AYRS, THOMAS D. RICE,** and **E. P. CARR.**

LOCATION AND BOUNDARIES OF THE AREA.

Lauderdale County, Ala., is embraced within the parallels 34° 43′ and 35° north latitude and the meridians 87° 12′ and 88° 12′ west longitude, and occupies the extreme northwestern part of the State. It is bounded on the north by Hardin, Wayne, and Lawrence counties, of Tennessee; on the east by Limestone County, Ala., and the Elk River; on the south by Lawrence and Colbert counties, of Alabama, and on the west by Tishomingo County, Miss., the south bank of the Tennessee River forming the boundary line on the south and west. Its greatest length is 57 miles in an east-and-west direction,

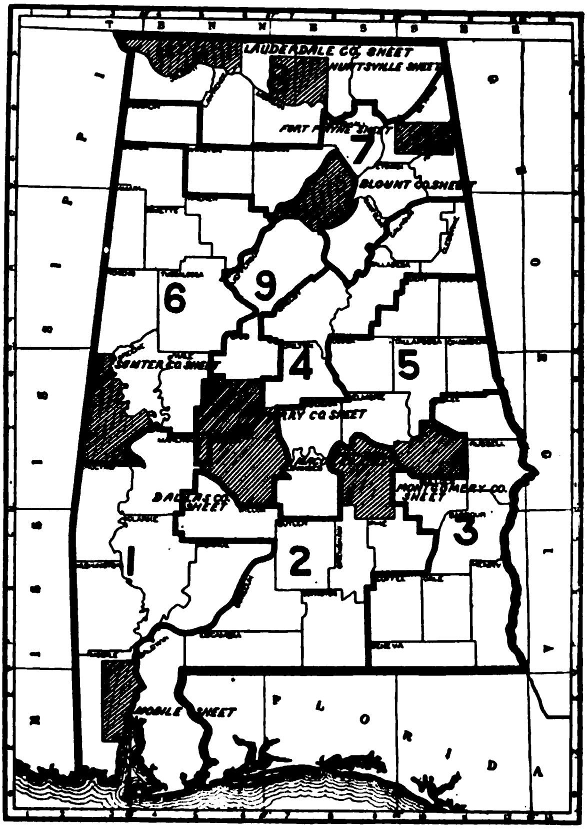

Fig. 15.—Sketch map showing location of the Lauderdale County area, Alabama.

and its greatest width from north to south 20 miles. The total area is 453,056 acres, or about 708 square miles. Florence, the county seat, is a thriving town of some 8,000 or 10,000 inhabitants, located on the river about midway of the county. Rogersville, in the eastern, and Waterloo, in the western part, are the only other towns of importance in the area.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Lauderdale County was one of the first sections of Alabama settled by white people, the early settlers coming from Virginia, the Carolinas, and eastern Tennessee. It was established as a county during the Territorial period of the State, and its organization was completed upon the admission of Alabama into the Union as a State in 1818. The first settlements were made along the Tennessee River, mostly upon the areas of Clarksville clay loam, which were soon cleared and have been under constant cultivation since. Scattered settlements were made along Cypress, Shoal, Bluewater, and the other large creeks. These gradually spread over other portions of the county, but there are thousands of acres still unoccupied.

The early settlers began the cultivation of cotton, corn, wheat, oats, and a few other minor crops. Cotton was the leading crop on the Clarksville clay loam. On the other types of soil corn was the most important. Up to the present time there has been but little change in the kind of crops or their relative importance.

Cattle and hogs have been raised regularly for local supply, but they have never occupied a prominent place in the county's resources. Both run at large nearly the entire year, the hogs feeding largely upon the mast in the oak forests.

About 1870 a colony of Germans settled at St. Florian. These people confined themselves to comparatively small farms (40 to 80 acres) and gave them careful cultivation. They have grown but little cotton, giving their attention instead to the products they were more familiar with, such as the grains, truck crops, and small fruits. They have been very successful, showing that much better results can be obtained from the small general farm than from the large cotton plantation.

Prior to the civil war the cotton plantations were worked by slave labor. At the close of that conflict everything was in a chaotic state, and the landowners found themselves without sufficient labor to operate their plantations. As a result hundreds of acres were thrown out of cultivation and soon occupied by a scrub growth characteristic of the "old fields" of the South, while their owners sought employment in the cities and in other parts of the United States. These "old fields" have been gradually brought back under cultivation, but wide areas are still unoccupied.

CLIMATE.

The climate of Lauderdale County is mild and equable. No extreme heat is experienced during the summer, the nights being cool during the entire season. Occasionally the temperature falls to zero or below in winter, but these occurrences are rare.

The following tables compiled from records of the Weather Bureau stations at Florence, in the south-central part of the county, and at Riverton, lying just across the Tennessee River, give the normal temperature and rainfall, and the dates of the last killing frost in spring and the first in fall:

Normal monthly and annual temperature and precipitation.

Month.	Florence.		Riverton.		Month.	Florence.		Riverton.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	*°F.*	*Inches.*		*°F.*	*Inches.*	*°F.*	*Inches.*
January	40.6	5.05	39.8	3.88	August	78.3	3.98	79.9	3.45
February	43.0	4.20	42.3	5.55	September	72.7	3.03	73.8	2.14
March	52.2	5.83	50.8	5.43	October	61.2	1.93	62.6	3.60
April	61.5	4.77	57.3	3.35	November	50.6	3.54	49.8	4.08
May	70.2	3.50	70.6	2.86	December	42.8	4.35	38.7	3.87
June	78.0	5.12	78.0	6.10	Year	60.9	49.75	60.4	48.15
July	79.5	4.45	80.6	3.84					

Dates of first and last killing frosts.

Year.	Florence.		Riverton.		Year.	Florence.		Riverton.	
	Last in spring.	First in fall.	Last in spring.	First in fall.		Last in spring.	First in fall.	Last in spring.	First in fall.
1896	Mar. 24	Nov. 9	....	....	1902	Mar. 20	Oct. 29	Apr. 9	Oct. 29
1897	Mar. 26	Nov. 17	....	Oct. 30	1903	Apr. 4	Oct. 25	Apr. 5	Oct. 18
1898	Apr. 8	Oct. 27	Apr. 8	Oct. 27	Average	Mar. 31	Nov. 4	Apr. 6	Oct. 24
1899	Apr. 7	Nov. 3	Apr. 8	Sept. 30					
1900	Apr. 1	Nov. 9	Apr. 2	Nov. 9					

PHYSIOGRAPHY AND GEOLOGY.

Lauderdale County is located within the physiographic province known as the Tennessee Valley, and presents a variety of surface features which have direct bearing upon the soils and agricultural interests. The elevation ranges from something over 400 feet at the river level to 800 or 1,000 feet on the high ridges along the Tennessee State line, but the descent to the river is by no means gradual; sharp bluffs, from 50 to 100 feet high, mark the inland boundary of the river bottoms, or rise directly from the river, throughout the greater part of its course. From these the country stretches away northward, in the eastern two-thirds of the area, in a broad, gently rolling plateau, comprising the best-developed farm lands. Into this plateau the larger streams have cut deep narrow gorges, through which they flow in tortuous channels until they emerge from the bluffs. Many of the smaller streams disappear in underground channels through this upland area, and appear as large springs at the base of the bluffs, the bed rock being massive limestone of the St. Louis group (Tuscumbia) of sub-Carboniferous age and of considerable purity, which, when free from chert, gives rise to the Clarksville clay loam soil, or, when mixed with large amounts of chert, to a phase of the Clarksville stony loam.

Beyond this formation a more level plateau, much dissected by erosion, extends nearly to the Tennessee line, where it is broken by a series of rocky ridges rising to elevations of 100 to 300 feet, from which a much broken plateau extends into Tennessee. Through this section the streams flow in wider, shallower valleys, and have formed extensive flood plains, even the smaller streams building some alluvial deposits. Here, also, the descent from the plateau to the stream bottoms is not so abrupt, but progresses by a series of choppy hills with small groovelike valleys extending for some distance each side of the stream. The largest unbroken areas of this second or interior plateau are on both sides of the Cypress creeks, between Shoal and Bluewater creeks, and between Anderson and Second creeks (the easterly one of that name is referred to). This section in general, is finely watered by many streams and springs, but the unbroken portion is poorly drained, and embraces what is known locally as the "barrens." The soils have evidently been derived largely from limestone, but rest at no great depth on very cherty beds, which erosion has uncovered in all but the level areas, and in consequence the broken and hilly areas in this section are occupied by a phase of the Clarksville stony loam, in many cases too stony for profitable general cultivation. The level areas are free from stone and occupied by the Clarksville silt loam.

Along Shoal and Bluewater creeks, in the northern part of the county, rocks of Silurian age (the Pelham [Trenton] limestone and a black coaly shale) outcrop, but have no influence on the soils.

The highlands of the western third of the county present a different aspect from the sections previously described, due to the presence of a more resistant rock—an iron-cemented coarse conglomerate, made up of subangular and rounded pebbles of quartz and chert. These are probably remnants of the Lafayette formation overlying the limestones. The more resistant portions have held up, forming narrow buttressed ridges, while the less resistant intervening places have given way, forming V-shaped valleys, whose slopes are covered with slabs of rock and a large quantity of quartz and chert gravel. These ridges, as already stated, rise to a height of 100 to 300 feet above the general level of the surrounding country, and are of fantastic shapes and almost mountainous topography. The streams are small but rapid, filling quickly, and often doing much damage to the lower lying country. The soils over this area are also mainly derived from limestone, but are modified by the disintegrated conglomerate and are invariably stony. The almost exclusive type is the least valuable phase of the Clarksville stony loam, little suited to farming operations, except for grazing sheep, goats, and swine, and possibly for growing apples, peaches, and grapes.

Lauderdale County is exceptionally well watered, many large stream systems crossing it in a general north and south direction and emptying into the Tennessee River. Abundant springs of pure water gush from every hill, many of them possessing medicinal properties and others valued solely for the purity of their waters.

SOILS.

The soils of Lauderdale County have been classified in six types, all of which have been mapped in areas previously surveyed. More than half the county is covered by a stony soil, somewhat less than one-fourth by a silt loam, about 22 per cent by a loam and a clay loam, 1 per cent by clay, and less than one-half of 1 per cent by sandy loam.

The following table gives the names and areas of each type of soil shown in the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Clarksville stony loam	235,712	52.1	Guthrie clay	5,376	1.1
Clarksville silt loam	104,320	23.2	Clarksville fine sandy loam	1,856	.4
Clarksville clay loam	60,992	13.4	Total	453,056	....
Clarksville loam	44,800	9.8			

CLARKSVILLE FINE SANDY LOAM.

The soil of the Clarksville fine sandy loam varies from 6 to 15 inches in depth and is a gray or light orange colored fine sandy loam of loose texture. The subsoil, to a depth of more than 3 feet, is a massive red sandy clay, more sandy in the upper portion, but acting as a clay throughout. The type is generally free from stone or gravel, except in very limited areas.

The largest area occurs about 3 miles northeast of Gravelly Springs and a few narrow belts are found along some of the small streams in the western part of the county, but the extent of this type is very limited and so little is under cultivation at present that it is of little importance.

The surface features are not uniform, but vary from low, rolling hills to narrow valleys. None of the type is too steep for cultivation. Surface drainage is very complete, but the subsoil is capable of retaining a large amount of moisture, and this combination of texture—a light, loose surface soil, easily cultivated, and a retentive subsoil—should make a very desirable type for special crops. The soil has been largely derived from disintegration and wash from sandy layers of remnants of the Lafayette formation which have been mixed to a certain extent with the clays of the underlying limestone strata. It is thus closely related to the Orangeburg fine sandy loam, and had it occurred in larger, deeper, and better developed areas would have been correlated with that type. The soil is so siliceous in character that, except by disintegration, it has undergone little change in the process of formation. The subsoil, being largely derived from limestone, has weathered deeply through solution. It is of a bright red color.

There are no cleared tracts of sufficient size to judge of crop yields or adaptation, but the Clarksville fine sandy loam would seem to be finely suited to peach culture and, where well drained, to cotton, though less productive of corn, small grain, and grass than most of the other soils of the county.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Clarksville fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12630	Soil	0.1	2.5	10.0	42.7	10.8	25.5	8.1
12631	Subsoil	.0	3.1	8.4	29.2	6.7	23.1	29.5

CLARKSVILLE CLAY LOAM.

The soil of the Clarksville clay loam, to a depth of 6 to 12 inches, is a brown or yellow loam or silt loam. The subsoil to 24 inches is a yellow clay loam, beneath which occurs a heavy red clay. On the tops of ridges, on eroded slopes, and in a few more level areas the red clay subsoil immediately underlies the brown soil, while on most level areas and at the foot of slopes the yellow subsoil extends to a depth of 3 feet. Both soil and subsoil are free from stone and gravel, except for narrow bands along some slopes.

The Clarksville clay loam occupies a large area in the Colbert bend of the river, extending nearly to the Waterloo road, east nearly to Cypress Creek, and west almost to Gravelly Springs. Florence is located on another area of the type which reaches east nearly to Shoal Creek. Other areas occur along the Huntsville road, extending from near the river bluffs several miles into the interior, until they blend with the Clarksville silt loam. A few outliers occur in the latter type.

The surface features presented by the Clarksville clay loam are those of a gentle erosion highland or plateau, with smooth rounded hills, having an average elevation of about 100 feet above the river, and with a gentle slope inland to the southern limits of the Clarksville silt loam. Sink holes and large springs are a feature of the formation, and no streams of any size traverse it. Several cross it by underground channels and emerge as springs. This is the only type of the area in which there is not an abundance of flowing water of fine quality. Wells are numerous, and many sink holes are used as watering places for stock.

Owing to the rolling surface natural drainage is adequate, but both soil and subsoil are capable of holding a good reserve of moisture for the use of growing crops. None of the areas is in need of artificial drainage. Care is necessary to avoid damage from erosion.

The Clarksville clay loam has been derived from massive limestone of the St. Louis group, and weathering has gone on to such an extent as to produce a mellow fertile soil of good moisture capacity, adapted to a wide range of crops in this climate.

Cotton forms the chief crop interest on the Clarksville clay loam, and though it has been cropped continuously for many years it still maintains an average yield of from one-third to one-half bale per acre throughout its extent, much of it producing three-fourths bale. Corn is next in importance and yields from 30 to 60 bushels per acre. Wheat has been recently introduced and gives heavy yields. Quite an acreage has been put out in strawberries, but they are not yet in bearing. Grass and forage crops do well, and a wide variety of garden crops is produced in a small way, not supplying the local demand. Grapes and apples are successfully grown, the vineyards centering around St. Florian, where, in the hands of German colonists, this type of soil has reached a state of productiveness in some measure approaching its possibilities. There is need of a greater diversification of crops, more attention to rotation, and a more general use of cover crops to realize the best from this valuable soil. Continued clean cultivation of cotton and corn has reduced the available organic constituents far below the optimum, and many tests have without exception shown the soil decidedly acid. An increasing acreage of cowpeas bespeaks improvements.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Clarksville clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12626, 12624	Soil	0.7	4.0	3.2	8.9	7.0	53.7	22.4
12625, 12627	Subsoil	.3	3.0	2.2	5.5	4.7	50.1	34.2

CLARKSVILLE SILT LOAM.

The soil of the Clarksville silt loam ranges from 4 to 8 inches in depth, and is a yellow or gray compact silt loam holding a perceptible amount of very fine sand in the first few inches, which renders it friable when dry. The color is often gray or white and the texture flourlike in a dry condition, but when wet it has a characteristic greenish-yellow color, is plastic, compact, and greasy. The subsoil is a massive yellow silt loam or a silty clay loam resting on a substratum of red clay loam or clay at from 2 to 3 feet in depth, although the yellow subsoil may extend to a depth of 6 to 8 feet in favorable situations. Both soil and subsoil are free from stone or gravel, except small local beds of nodular chert and iron concretions.

This type is developed on the table-lands in the middle portion of the county eastward from Bluff Creek to the Limestone County line and is very uniform throughout the area. Narrow strips extend north into Lawrence and Wayne counties, Tennessee, but it rarely is found close to the river, for topographic reasons. The Clarksville silt loam is essentially a table-land type occurring only in level, gently inclined, or slightly undulating areas. Any abrupt change in elevation is marked by stony areas and such changes in drainage conditions as to produce the Clarksville stony loam or Clarksville clay loam. Depressions and basinlike areas in this type, through further lack of drainage and consequent chemical and physical changes, give rise to Guthrie clay. The yellow color, puddled condition, and excessive acidity of this soil, even in its native state, point to the cause—insufficient drainage—consequent on its natural position and generally level surface, while the presence of the red clay strata, identical with the subsoil of Clarksville clay loam at no great depth, points to its intimate relation with that type and derivation from it through drainage conditions. In undulating areas the red clay often approaches to within 2 feet of the surface, sinking lower as drainage decreases until in the depressions devoid of drainage the type gives way to Guthrie clay.

The Clarksville silt loam has been derived from the solution of many feet of limestone of the St. Louis group and represents the insoluble residue. The iron salts, which give much of the color to soils, are in this case in a lower state of oxidation and produce the distinctive yellow color. Weathering has also been much retarded, and the type is in an acid condition, as well as very deficient in organic matter.

The Clarksville silt loam, or "barrens," as it is widely known from the scant growth of timber it supports, has long been held in poor esteem because of the small returns secured when farmed to cotton in the usual way, and but a small proportion of its area has been cleared. In the last few years it has risen somewhat in popular estimation, as a few have shown that it responds readily to treatment designed to correct the abnormal conditions already pointed out in this description. Corn and cotton are still the chief crops, and although the average yields are below those obtained on the other tilled soils of the area, a few enterprising farmers are obtaining as good yields as on any other type. Some wheat is grown and medium yields of the finest quality result. When the acidity is corrected good crops of clover are secured. Grass is able to withstand severe drought on this type. Opportunity is unlimited to make of this a fine soil for corn, wheat, and grass by intelligent methods, including rotation, subsoiling, and liming.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Clarksville silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
12632-12636.......	Soil	0.2	1.5	1.9	9.6	7.2	62.9	16.6
12637-12633.......	Subsoil	Tr.	.6	1.2	6.3	4.8	48.8	38.2

CLARKSVILLE STONY LOAM.

The soil of Clarksville stony loam is a brown, gray, or yellow loam or silty loam 6 to 10 inches in depth, underlain by a subsoil of yellowish-red clay loam or stiff red clay to a depth of more than 3 feet, the whole containing from 20 to 60 per cent of angular chert (flint or chalcedony) and occasionally some rounded quartz gravel.

It is the most extensive and widely distributed type of the area, and includes the bluffs along the river and large stream courses, the rough, broken land and cherty knolls, and the ridges in the table-lands, and bears an intimate relation to the other Clarksville types found here. There are three distinct phases of the type, similar except in color and topography, the latter, as affecting accessibility, most influencing the value of the land for agriculture. The most extensive phase has a yellow silty loam soil, with yellowish-red clay loam subsoil, both filled with angular chert. This phase occurs as choppy hills and groovelike valleys bordering the larger streams, and is the result of the erosion by which the present drainage has been established. Another extensive and the least valuable phase occupies large areas, mostly west of Bluff Creek, and is mainly a thin gray loam or silty loam, with heavy yellow and red clay loam subsoil, both containing a large quantity of chert fragments and rounded chert and quartz gravel derived from iron-cemented conglomerate, large slabs and ledges of which are scattered on the surface and protrude from the hillsides. This rock has resisted erosion and solution, resulting in the formation of narrow, buttressed ridges from 100 to 300 feet higher than the intervening groovelike valleys eroded in the unprotected, less resistant limestone. This section presents the most broken topography of the county, and is sparsely settled and little tilled. The third phase is least extensive and most valuable, and has a brown loam soil and heavy red clay subsoil filled with large angular chert blocks. It occurs as rolling hills along the streams in Clarksville clay loam areas and as narrow ridges of slight elevation within that type. Being more accessible and easily tilled than the rest of the type, it is more largely cleared and under cultivation. The whole type is thoroughly drained.

The Clarksville stony loam is derived from chert beds and layers of limestone. Its stony character is the distinctive feature, the fine earth portion not differing materially from the other Clarksville types in this area.

Cotton and corn are the principal crops, and give only fair returns. The former will not average one-third bale per acre, while 30 bushels per acre of the latter is considered a fair yield. The type is best suited to the production of fruit, particularly apples, peaches, Kieffer pears, and grapes. Fruit crops are, however, rather uncertain, and few, if any, existing orchards on this soil receive much care. More attention should be paid to setting out apple trees near the foot of slopes in the coves, that they may secure the benefit of soil wash, greater immunity from fungous diseases through better "air drainage" and protection from the summer heat, as this is about the southern limit of successful apple culture. Peaches will do better near the tops of the ridges, and grapes, of course, need good exposure to the sunlight. The timber has been the chief source of revenue from these lands, but little of merchantable value remains.

The following table gives the average results of mechanical analyses of the fine earth of this type of soil:

Mechanical analyses of Clarksville stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
12638-12642	Soil	1.2	4.1	3.7	7.5	4.4	51.6	27.3
12639-12643	Subsoil	1.4	3.8	3.8	7.6	3.3	42.5	37.4

CLARKSVILLE LOAM.

The soil of Clarksville loam, to a depth of 10 or 12 inches, is a rich, mellow, dark-brown loam, in which silt is a very prominent constituent. The subsoil is of much the same textural character as the soil, but heavier, and in some cases becoming a silty clay of drab color. In narrow areas along the smaller streams and near the hills along the river bottoms, where the break from the tablelands is by rounded hills instead of by the usual vertical bluffs, the soil and subsoil contain from 20 to 50 per cent of subangular chert gravel, ranging from small particles up to pieces 2 inches in diameter, and the fine-earth portion is often of a red color. These areas approach the Cumberland loam in texture and crop value, but, being too narrow to be shown separately on the map, have been indicated by gravel symbols. The stream channels and overflow troughs are occupied by pure gravel and worthless for agriculture. Narrow bars of gravel deposited in flood times occur throughout the large creek bottoms. Strips a few yards in width along the river bank are often a fine sand and are used for melon culture.

This type reaches its best development as bottom lands along the Tennessee River, occurring in this county as an interrupted strip from one-quarter to 1 mile in width and covering the islands in the river. Large typical areas have been formed on Cypress, Shoal, and Bluewater creeks at a distance of several miles from the river and before they cut their narrow gorges through the bluffs to the river bottoms. On the creeks it attains its greatest width at the confluence of the larger tributary streams.

The surface of the Clarksville loam forms a gently inclined plain, higher next the immediate banks of the river, where a strip of fine sand often occurs, and sloping back to the rocky bluffs, at whose bases many large springs emerge, forming sloughs. Where the gravelly phase occurs on small streams the slope is from the base of the hills toward the streams, and where this phase is developed along the river the slope is both from the hill and from the river bank, forming a gentle V-shaped trough. Along the river the average elevation is from 20 to 30 feet above low water and the soil is of great depth, while bordering the small streams the range of elevation is slight and the depth of soil rarely exceeds 3 feet. Here also it is usually underlain by a bed of chert gravel.

The main area of the type is generally well drained for an alluvial soil, but it is traversed by many sloughs and small marsh areas too wet for cultivation. Though loamy in texture, it is capable of holding a large moisture supply. The gravelly phase, locally known as "second bottoms," from its position and large gravel content is more thoroughly drained. Danger from overflow during the growing season is very slight, but the spring freshets on the creeks work many changes, tearing material from one place, ruining the land at that point, and depositing and enriching areas farther down. To lessen this danger, substantial stone walls are frequently built across the creek bottoms to prevent erosion and to induce deposition below by breaking the force of the current on the flood plains. As a consequence narrow transverse ridges of fine sand are often laid down immediately below these fences and are used as a location for field driveways. The Clarksville loam is mainly of alluvial origin from limestone débris washed down and deposited in time of flood by the river and its tributaries, and the gravelly phase is in part colluvial from the adjacent hills. It consists mainly of fine sediments in a mellow and well-weathered condition and of high natural productiveness.

These bottom lands were originally covered with a heavy growth of canebrake and large timber, but early received the attention of the settlers, and are well cleared and justly famed as a corn soil, producing a heavy growth of stover and yields of grain ranging from 30 to 80 bushels per acre. The gravelly phase, or second bottoms, combines marked productiveness with different drainage conditions. This renders it particularly suited to cotton, for which crop it is the best soil of the area, producing, under intensive cultivation, 1 bale or more per acre through successive seasons and giving high average yields under ordinary conditions of cultivation. Recently more attention has been given to grass and some market-garden crops on this type with much success.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Clarksville loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12620, 12618	Soil	0.0	0.2	0.3	1.3	4.1	69.9	24.1
12621, 12619	Subsoil	.0	.4	.3	2.1	5.6	52.7	38.6

GUTHRIE CLAY.

The soil of the Guthrie clay, locally termed "crawfish" or "pipe-clay land," to a depth of 6 or 8 inches is a drab, gray, or white heavy silt loam, compact and puddled when wet, but flourlike when dry. The subsoil to 3 feet or more is a gray or yellow, often mottled silt clay, massive, plastic, and impervious. The soil is free from stone and gravel, except for some fine chert fragments and iron concretions in the deep subsoil.

This type occurs in basinlike depressions and in narrow belts around the heads of some drainage systems where there is so little surface inclination that water stands in pools in wet seasons, and its characteristic features are largely due to lack of drainage, for it is a cold, sour soil, of little present value. Tile underdrainage, heavy applications of lime, and the incorporation of coarse organic matter should render it of use in the production of grass and wheat, but the expense of so improving it is not warranted under existing land values in this section.

The Guthrie clay, originally derived from massive limestone, owes its present condition and distinguishing characteristics to a more recent development of swampy conditions in depressions and in areas of obstructed headwater drainage. Such areas occur in the Clarksville silt loam and the Clarksville clay loam, and its mode of formation is already indicated by its being confined exclusively to those situations.

Bermuda grass seems to be the only successful crop on the type in this area. It is largely uncleared and supports a good timber growth characteristic of such soil, chiefly white oak, post oak, willow oak, gum, hickory, tulip, and some beech. Small areas of from one-quarter acre to 2 acres, occurring in the surrounding types, even when partially drained by ditches, remain unproductive and are usuually avoided at planting time. Little improvement can be expected on this soil until the price of surrounding land rises sufficiently to warrant the expense of tile drainage, although Guthrie clay has in it the making of a strong wheat and grass land well suited to stock farming.

The following table gives the results of mechanical analyses of the soil and subsoil of this type.

Mechanical analyses of Guthrie clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12622	Soil	0.0	0.3	0.9	5.9	4.0	64.9	23.7
12623	Subsoil	.0	Tr.	.5	4.1	2.9	47.0	45.3

AGRICULTURAL METHODS.

The cultural methods in use in Lauderdale County do not differ materially from the general practice throughout the South where cotton and corn form almost the sole crop interests. Plowing is carried only to a shallow or medium depth, insufficient to produce the largest yields or to secure a desirable improvement in the soil texture. In consequence of this practice the implements in use are usually small and light, although a few of the more progressive farmers are using disk plows, harrows, and other modern implements with such marked success that their use is rapidly becoming more general.

Corn is planted in rows about 4 feet apart, leaving but one or two stalks in each hill. On the heavy soils, so general in the area, a heavy growth of stalk is produced, but only the ears and the blades, stripped and cured for hay, are gathered, while the stalk is left standing to be subsequently burned or plowed under before the succeeding crop is put in. The large, dry stalks are of little benefit to the soil when plowed under, and great saving would result if they were gathered at the proper time, shredded, and fed to stock, returning the manure to the soil.

The fields on which cotton and corn are grown are left bare of vegetation during the winter and exposed to washing and erosion by the heavy rains of that season; whereas they might easily be protected by planting a cover crop, such as cowpeas, barley, rye, or crimson clover, between the rows at the time of the last cultivation, giving an increased annual revenue from the field and conserving the soil energy now so severely taxed.

Systematic crop rotation is the rare exception in this area, and there is great opportunity for improvement of the soils and yields of crops by this means. Attention to this matter can not be too strongly urged, as a continuance of present methods can only result in further impoverishing the soils and diminishing the yields.

Cowpeas are grown to some extent by the best farmers and are recognized as of great value as a soil renovator and as a crop, pea-vine hay being largely used for the work stock and bringing a good price at all times.

The cotton seed is sold to the oil mills and not returned to the fields, as in former times, resulting in a still further drain on the productiveness of the soil, which is met, only where absolutely necessary to produce a paying crop, by the application of small quantities of some commercial fertilizer. When this treatment fails to produce profitable yields, the field is thrown out of cultivation and new land cleared to take its place. A heavy growth of broom sedge, weeds, and scrub trees takes possession of the abandoned fields, making them difficult of reclamation.

Until the last few years little attention has been given to the cultivation of wheat, but the acreage is gradually increasing, and the yields on the Clarksville clay loam are satisfactory, running as high as 25 to 30 bushels per acre. On the Clarksville silt loam the common yield is from 10 to 12 bushels, though it is said the quality of grain on the latter type is superior and commands a higher price.

For all crops except cotton the land is prepared with the turn plow or disk plow and the soil fairly well inverted. For cotton the land is bedded and the preparation and cultivation accomplished with a variety of small tools. Fertilizers are applied in the rows at or before planting. Small quantities, mostly of low-grade mixtures, are used.

AGRICULTURAL CONDITIONS.

By reason of difference in transportation advantages and, to a certain extent, of soil differences, the agricultural population of Lauderdale County falls into two large classes. Settlement first began and has since expanded largely in that part of the county adjacent to the Tennessee River, because for many years that waterway furnished the best means of transportation, the bulky staple—cotton—could be the more readily marketed, the soils of that district responded more readily to tillage, and the bottom lands, covered with a heavy growth of cane, furnished a fine natural pasturage for the stock. Here the lands have long been well cleared, and the inhabitants thrifty, progressive, and prosperous. The same conditions obtain farther in the interior of the county along the larger stream bottoms.

The greater part of the interior, consisting of level plateaus and stony ridges, is sparsely settled and presents the appearance of a newly settled country. Handicapped for many years by lack of communication and transportation and by the consequent lack of educational advantages, the early settlers in this section have made little progress up to the last few years, and the absence of prosperity is unmistakable. Many of the poorer classes barely eke out a daily existence from the products of the forest and the returns from a small plat of tilled ground. However, changes for the better are rapidly taking place and a great development may be looked for here in the next few years.

Along the river the farms are occasionally worked wholly or in part by the owner, but more often divided into small tracts and rented out for a part of the crops grown, usually a definite number of pounds of lint cotton per acre and a third of the grain and forage produced. In size the farms range from several hundred to several thousand acres, large farms being the rule.

A practice, probably originating in part from early custom and in part from lack of fences, consists in opening the bottom lands for common pasturage after the crops are gathered in the fall, and many head of stock—cattle and mules—are driven down to browse on the cane, stubble, and standing cornstalks, with no care or protection from sudden spells of cold weather, which occasionally visit this latitude in severe winters. Mules when brought out in the spring are said to be in good flesh but soft in muscle, and require grain feed for some weeks before they can be put to work.

Farther inland the farms are generally smaller in size, ranging from a few to several hundred acres in extent, and are worked mostly by the owner. Few cleared areas of any size are found in the interior, and about 5 per cent of the land still belongs to the Government and is open to settlement on complying with the requirements of the Land Office. It should be noted in this connection that most of the Government land now remaining is too rough or stony for profitable tillage, while cleared and improved lands remain at their present low value.

Labor on the large farms is performed mostly by colored help, which is fairly efficient, being particularly suited to the cultivation of cotton, the picking of which gives employment to both sexes and all ages. Labor is scarce in the interior of the county, and is mostly performed by the owner or tenant and members of his family. Some of the northern districts have little or no colored population. Most of the whites there not engaged in agriculture find employment in the various lumbering operations.

The cost of labor, both of men and teams, is cheaper than in sections farther north, as the cost of living is much less in this climate. This fact, more than anything else, has militated against the introduction of improved implements. The average wage for males is 50 cents a day, and for females 30 cents; for services of man and team, about $2.50.

In point of acreage corn is the principal crop of the area, about 48,000 acres being planted annually, with an average yield over the entire county of 15 bushels per acre. It is grown on every type of soil represented, but the yields vary considerably with the soil and drainage. The Clarksville loam of the river and stream bottoms is the strongest corn soil of the area, closely followed by the Clarksville clay loam. The Clarksville stony loam and Clarksville silt loam are about equal in yield, while the gravelly phase of the Clarksville loam stands very low, because of too thorough drainage, and the Guthrie clay is very uncertain, but makes good yields in favorable seasons.

Cotton is the next crop in relative importance, with an acreage of about 30,000 and an average annual production of 10,000 bales, or, in other words, an average yield of 1 bale from 3 acres over the whole county. It is produced mostly on the Clarksville clay loam and the Clarksville stony loam and on the gravelly phase of the Clarksville loam, or second bottoms, which brings the largest yields, amounting in a few cases to as much as 1 bale per acre. Only a small quantity is grown on the Clarksville silt loam, and practically none on the Guthrie clay.

Wheat is the next crop in importance, and is represented by an acreage of from 5,000 to 6,000 acres annually, with an average yield of about 10 bushels per acre over the county. It is produced mostly on the Clarksville clay loam and the Clarksville silt loam. The former, in a few cases, yields as high as 25 bushels per acre, and the latter, with fertilization, about 12 bushels per acre. The acreage of this crop is gradually increasing, and better yields are being secured year by year.

About 3,000 acres are sown in oats, half of which area is harvested for grain, with an average yield of 10 bushels per acre, while the other half is used for hay, producing about 1 ton per acre. This crop is grown on all the soils, and the yields are too variable to draw any comparisons between the types.

Millet and Hungarian grass are important crops, and yield over 1 ton per acre, on the average. Potatoes and vegetables are grown only to a limited extent, and do not supply the local markets. Irish potatoes do well, yielding from 50 to 60 bushels, and their production should be largely increased. Sweet potatoes yield about 60 bushels per acre, on the average. About 500 acres each of sorghum cane and cowpeas are grown annually in the county.

Transportation facilities are very poor. The Louisville and Nashville Railroad enters the county near Pruitton on the north and crosses to Florence, where connection is made with the Southern Railroad. The Louisville and Nashville Railroad traverses a rough part of the area, and no towns or shipping points of any size are located on it. The large sections of the area to the east and west of this line are entirely without railroad service, and have communication only by wagon road or ferry with the Southern Railroad, on the other side of the river.

The wagon roads are mainly heavy dirt roads, rutting badly and being deep in mud in wet weather, although keeping in very good condition in dry seasons. Soft chert exists in the hills in great quantities and is easily obtained. It makes a very fine surfacing material, and several of the roads have been improved by this means.

SOIL SURVEY OF BLOUNT COUNTY, ALABAMA.

By **WILLIAM G. SMITH** and **F. N. MEEKER.**

LOCATION AND BOUNDARIES OF THE AREA.

Blount County lies in the northeastern part of Alabama, in what is popularly known as the mineral section of the State. It is quite irregular in outline and is surrounded by Walker, Cullman, Marshall, Etowah, St. Clair, and Jefferson counties, the latter including the city of Birmingham, which is distant about 40 miles from the center of Blount County.

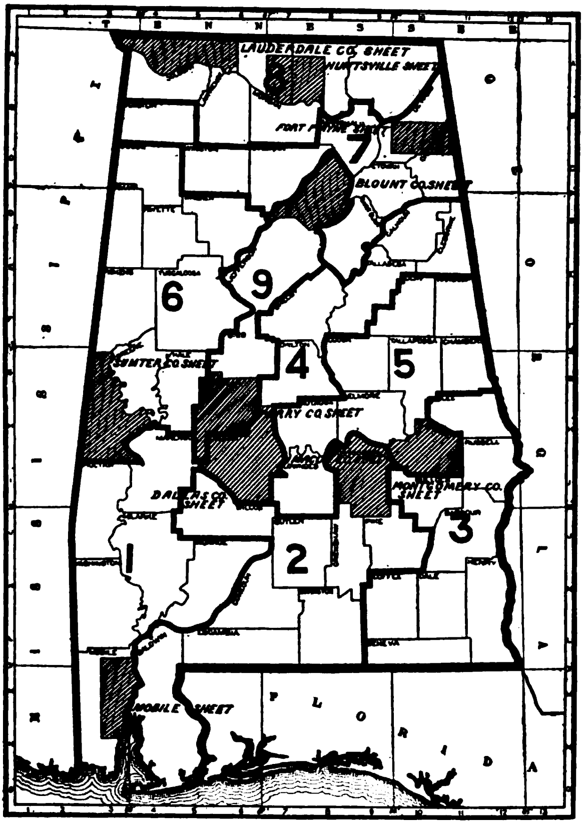

FIG. 16.—Sketch map showing location of the Blount County area, Alabama.

The base map used in this survey was made with the plane-table by the soil survey party. A township and section plat of the county, on file at Oneonto, the county seat, was used as a check in making up the final base.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Alabama was organized as a Territory in 1817 and as a State in 1819. Blount County was established February 7, 1818, and at that time included a large part of northeastern Alabama. By subsequent acts of the State legislature several of the adjacent counties now existing were formed out of what was originally Blount County, until at the present time its extent barely exceeds the requisite constitutional size of 600 square miles, the actual size, by the most recent act affecting its boundary, being about 626 square miles. By local election held April 23, 1901 (authorized by act of the State legislature approved March 5, 1901), the Mulberry Fork of the Black Warrior River was fixed as the boundary line between Blount and Cullman counties, giving to the latter lands previously included in the former.

The people now living in Blount County are descendants mainly of English stock who came from Georgia, Tennessee, the Carolinas, and Virginia, beginning in 1816. The early settlers followed closely upon the land concessions obtained from the Indians by treaty from time to time with the United States Government, the last of these being with the Cherokees in 1835. The lands were usually surveyed into townships and sections by the National Government (under the act of 1795) as soon as the concessions were obtained and were sold to the white settlers. Such surveys in Blount County were made mainly from about 1816 to 1837.

The early agriculture of the whites followed quite closely that of the Indians, namely, the growing of such crops as corn, vegetables, etc., for home consumption. During the forepart of the nineteenth century some plantations having slave labor were opened up in the county, and considerable corn, wheat, oats, and cotton were grown and hauled to Guntersville, on the Tennessee River, also to Decatur and Tuscaloosa, and shipped to distant markets. In 1874 railways began to be used for the shipping of products, the Louisville and Nashville being built through the county in that year.

Apple growing was among the early industries, and up to the period of the civil war had assumed quite large proportions. The war, however, seriously checked all industries in Blount County for many years. The apple most extensively grown and marketed prior to the civil war was known as the "Pennsylvania" or "Fowler" apple. It was introduced from North Carolina, by John Fowler, during the early settlement of the county. It was a winter type of apple, quite large, and with an attractive red skin, with flesh of fine flavor and texture. Owing to an attack of "scab" it has almost gone out of existence, only a few trees being now found growing in the county. Of the winter apples now grown, the Winesap, Reese Seedling, Arkansas Black, and Ben Davis are favorably mentioned. The Hackworth is a favorite summer apple. Of the peaches, the Elberta is mentioned as the best for marketing, there being, however, several other varieties desirable for local use. The value of the agricultural products of the county at present is relatively small, but the interest that seems to be manifested in fruit growing, stock raising, and the growing of crops suited for stock foods bids fair to see the county rank considerably higher in the value of these products in the future.

CLIMATE.

The winter temperature of Blount County averages about 43° F., with a range of from about 5° to 70° F. The summer temperature averages about 78° F., with a range from about 55° to 105° F. The average temperature for the year is about 62° F.

The average date of the last killing frost in spring is April 6, and of the first killing frost in the fall October 22. The actual dates of killing frosts may vary from these averages a week or ten days either way from year to year. Based on the average dates, the period during which crops may be grown without danger of killing frosts is about six and a half months.

The winters are, as a rule, mild, as the temperature readings given would suggest. There are exceptional winters, however, when temperature near to and below zero occurs. The winter of 1904–5 is said to have been the most severe in twenty-five years. The soil, as a rule, is seldom frozen to a depth of more than an inch or two, and then only for a very few days. Snow falls to a depth of one-half inch to 10 inches, but rarely remains on the ground more than two or three days. In all, the climatic conditions admit of a wide latitude in the growing of summer crops, while certain so-called winter crops, suitable for stock range, may be relied upon through the winter. For the comfort and safety of stock, however, good shelter should be provided to tide over the few severe frosty and cold wet days that occur more or less regularly every winter.

The average annual precipitation is about 52 inches, which is usually quite well distributed throughout the year, ranging from 2 to 4 inches during the fall months and from 4 to 6 inches during the other months. This is ample for the growing of crops. The lower precipitation during the usual harvest season of the staple crops also favors the farmer. During the summer months the precipitation is usually in the form of light showers, while in late fall and winter it occurs more often as heavy rains in periods of one to three days' duration. This would suggest the advisability of growing winter crops as a cover on exposed hillsides and slopes to prevent washing and gullying.

Thunder storms and wind storms of some severity are shown in the records, but as a rule these do not do much damage. The valleys are sheltered by ridges and mountains which lie almost exactly transverse to the prevailing northwest winds. Tornadoes have occurred in Alabama, but recently at least none seem to have touched Blount County.

The following table, compiled from the Weather Bureau records, shows the normal monthly and annual temperature and precipitation for Blount County:

Normal monthly and annual temperature and precipitation.

Month.	Oneonto.		Ashville.		Month.	Oneonto.		Ashville.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	*In.*	*° F.*	*In.*		*° F.*	*In.*	*° F.*	*In.*
January	42.8	5.46	42.6	2.82	August	78.0	4.08	79.7	3.75
February	42.7	5.57	43.5	5.16	September	73.0	2.21	73.7	2.82
March	53.2	6.66	53.0	6.41	October	61.2	3.27	62.0	2.92
April	60.7	4.82	61.2	5.54	November	50.6	4.69	51.2	2.80
May	70.3	4.34	69.8	2.89	December	42.2	4.50	43.6	5.80
June	76.7	4.80	78.5	3.70	Year	60.8	55.26	61.7	48.53
July	78.0	4.86	81.8	3.92					

PHYSIOGRAPHY AND GEOLOGY.[a]

The surface of Blount County consists mainly of parallel valleys, ridges, and mountains having nearly northeast-southwest trend, and cut by minor transverse valleys or gaps. The ridges and mountains range in elevation from about 600 to 1,400 feet above sea level, while the valleys, as a rule, lie 50 to 400 feet lower. The so-called "valley" lands of Murphrees and Browns valleys range in width from about 1 to 2½ miles, the surface varying from moderately flat to fairly hilly, where secondary ridges occur within the valley proper, some of the hills being as high or higher than the mountain lands on each side. The tops of the so-called mountains vary in width from about 4 to 12 miles, the surface being sometimes flat and at others consisting of gently rolling slopes.

The steep and rugged slopes are confined mainly to areas where the upward tips or edges of synclinal folds of rock strata outcrop. The more pronounced of these flank Murphrees and Browns valleys, while the southeastern boundary of the county lies next to one of these steep slopes.

There are a great many minor hills and slopes, some due to faults in and secondary movements of the underlying rock strata, and others to the subsequent erosive action of streams. As a whole, the southern half of the county is rather more hilly and broken than the northern part, the central and northern parts being characterized by wider valleys and wider flat-topped mountains.

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[a] Matters pertaining to the geology of the area are based mainly on different reports by the State geologist, Dr. Eugene A. Smith.

The county is drained almost entirely by the Locust and Mulberry forks of the Black Warrior River and their several branches, Blount County embracing much of the headwaters of this drainage system. The direction of the drainage is mainly southwest. The portion of the north part of Blount County embraced in the old Cherokee Indian Reservation is drained by Browns and Big Spring creeks, which flow northeasterly, emptying into the Tennessee River 12 or 15 miles to the north.

The rock strata of Blount County consist of limestone, sandstone, shale, and chert, all belonging to the Cambrian, Lower Silurian, Devonian, or Carboniferous periods, during which the area intermittently formed the floor of an interior sea that covered most of the Mississippi Valley.

The sediments carried in from the erosion of the height of land said to have existed along the Atlantic border were variously distributed on the floor of this sea, being eventually consolidated into the sandstones, shales, and other rocks now found. At the close of the Carboniferous period the area was permanently elevated and by folding and subsequent erosion assumed the main features of topography already described.

In the constituent strata of Blount County are found conveniently placed almost side by side iron, coal, and limestone, a combination necessary for the cheap and successful production of iron.

The drinking water is obtained from wells and springs, some of the latter carrying sulphur and iron. Blount Springs is perhaps the most noted of the sulphur springs.

SOILS.

The soils of Blount County are derived from the weathering of consolidated rocks which themselves are of sedimentary origin. These rocks varying much in the texture of their constituent particles give rise to sandy loams, fine sandy loams, loams, and clay. Eight distinct types are shown in the soil map. All of the soils are more or less clayey and, except where rough and mountainous, are naturally fairly productive. The following table shows the area of each type of soil:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Dekalb sandy loam	168,512	42.1	Meadow	9,216	2.3
Dekalb fine sandy loam	93,504	23.4	Upshur sandy loam	8,320	2.1
Dekalb clay	54,144	13.5	Hagerstown stony clay	6,848	1.7
Fort Payne stony loam	44,992	11.2	Total	400,256	....
Upshur loam	14,720	3.7			

DEKALB SANDY LOAM.

The Dekalb sandy loam consists of about 10 inches of gray to slightly brown, medium to fine textured sandy loam, underlain by a yellowish-brown light sandy clay subsoil to a depth of 36 inches or more. As a whole the type is only moderately stony, much of it consisting of flat mountain tops and easy slopes comparatively free from stone fragments, while on the steeper slopes bordering the valleys the surface may be quite stony, huge fragments and extensive exposures of sandstone marking the line of outcrop of the underlying rock strata.

A stony loam phase and a rock outcrop phase of the type are indicated on the soil map by different symbols. The stony phase usually includes areas having sandstone fragments 3 to 20 inches broad and 2 to 10 inches thick and varying in quantity from about 10 to 40 per cent of the soil mass. The rock outcrop phase is considerably more stony and includes the areas of rock outcrop already mentioned. The typical soil may contain small rock fragments varying from a mere trace to possibly 10 per cent.

The Dekalb sandy loam occurs mainly along the crests and slopes of East Red Mountain and West Red Mountain. The surface in places is quite hilly and rough, but the flat tops and easy slopes of the mountains vary from rather level to gently rolling in character. The type is well drained naturally, but as a rule is not droughty except where the underlying rock approaches near the surface.

The Dekalb sandy loam owes its origin to the weathering of a gray to brown sandstone, composed mainly of medium-sized quartz grains, and forming a member of the Coal Measures.

The higher lying areas of the type, such as those bordering the larger valleys, by reason of their greater immunity from late killing frosts in the spring, have been found well adapted to peaches, apples, plums, and cherries. Such areas are often the more stony parts of the type and are therefore not so well suited to the staple crops. Often the less stony areas are also well suited to peach growing.

The staple crops and vegetables do well on most of the type. Cotton yields from one-fourth to one-half bale per acre and corn from 5 to 20 bushels under the cultural methods ordinarily followed. Manuring and rotation of crops would increase these yields very much. Sorghum and forage crops give fairly good yields. As a whole the Dekalb sandy loam is not naturally productive, but it is capable of improvement by proper methods of cultivation. The land has a value of about $2 to $7 an acre.

The table following shows the average mechanical analyses of the fine earth of the Dekalb sandy loam.

Mechanical analyses of Dekalb sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12121, 12509	Soil	0.5	6.0	17.2	41.3	11.5	15.3	8.3
12122, 12510	Subsoil	.2	5.0	14.4	32.0	8.4	13.8	26.0

DEKALB FINE SANDY LOAM.

The Dekalb fine sandy loam consists of 8 inches of gray fine sandy to silty loam, underlain by a yellowish, rather heavy fine sandy loam to clay loam. Some phases of the type bordering the larger streams are rather more sandy than the typical soil; and here, too, a stony loam phase occurs, but rock fragments are not common, and the type as a whole comes well within the limits of the opening description.

The main body of the type occurs mostly in the central part of the county, occupying the flat top of the mountain on which are located Hendrick, Clarence, Snead, McLarty, and Nectar.

The surface of the Dekalb fine sandy loam varies from flat to gently rolling, a few steep slopes being found near some of the larger streams. The type is quite well drained naturally, though in a few places artificial drainage is desirable, and may be easily secured by running open ditches to some near-by natural drainage channel.

The Dekalb fine sandy loam owes its origin to the weathering of a fine-grained grayish to brownish sandstone, a member of the Coal Measures.

The Dekalb fine sandy loam is well adapted to the production of the staples, including forage crops, as also to small fruits, orchard fruits, and vegetables. Cotton yields from one-fourth to three-fourths bale, corn 10 to 30 bushels, and wheat 10 to 20 bushels per acre, and forage crops are reported as producing well. The larger part of the type is under cultivation. That portion still in forest supports a growth largely of oak, hickory, and shortleaf pine. Land of this type can be purchased for $5 to $20 an acre.

The following table gives the average results of mechanical analyses of samples of Dekalb fine sandy loam:

Mechanical analyses of Dekalb fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12513, 12515	Soil	0.3	0.8	2.4	18.3	19.8	37.1	20.3
12514, 12516	Subsoil	.2	.7	1.8	15.4	17.0	32.3	32.3

UPSHUR SANDY LOAM.

The Upshur sandy loam consists of about 10 inches of gray to reddish-gray fine sandy loam, underlain by a deep-brown to red sandy clay subsoil. As a rule the type is quite free from rock fragments, though on some of the steeper slopes these and massive outcrops similar in character to those noted in the Dekalb sandy loam occur, and are shown on the map as far as possible by different symbols. The main distinction between the two types is that one has a yellowish-brown and the other has a reddish sandy clay subsoil.

The Upshur sandy loam is associated with the Dekalb sandy loam, bordering Murphrees Valley. It occurs also in Browns Valley. The surface varies from gently rolling to hilly and rugged. On the broad, easy mountain slopes the surface is flat to gently rolling, while on the crests and steep slopes it is more rough. The natural drainage is good, and under the climatic conditions here existing the type is not subject to drought.

The Upshur sandy loam is derived from the weathering of a brown to red stratified sandstone, which forms a part of the Coal Measures. This sandstone is composed mainly of medium-sized quartz particles, cemented together by clay and iron compounds. Small rounded quartz pebbles the size of peas are sometimes embedded in the rock, and these also appear in places in the soil and subsoil of this type.

The Upshur sandy loam is found by experience to be naturally more productive than the sandy loams having yellow or light-brown subsoils. This is in line with observations made by the Bureau in other surveys. It is quite well adapted to the production of staple crops, as well as to vegetables, small fruits, and orchard fruits. The higher lying areas are best suited to peaches, because of greater immunity from late killing frosts in spring.

Much of the Upshur sandy loam is in cultivation. The yield of cotton ranges from one-fourth to three-fourths bale, corn 10 to 25 bushels, and wheat 8 to 25 bushels per acre, and vegetables and small fruits are reported to do well. With improved methods of culture the type could readily be made more productive, as it has the essentials of a fertile soil. It has an estimated value of $5 to $15 an acre. That portion still in forest supports a growth of oak, hickory, and pine.

The following table gives the average results of mechanical analyses of samples of the Upshur sandy loam:

Mechanical analyses of Upshur sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12127, 12533	Soil	0.7	2.6	9.3	45.0	16.7	13.8	11.5
12128, 12534	Subsoil	.1	3.8	13.7	30.4	7.3	20.1	24.6

UPSHUR LOAM.

The Upshur loam consists of about 8 inches of loam or silty loam, varying from brown to dark Indian red in color. The subsoil consists of a silty clay to a heavy clay, usually red brown to a deep Indian red in color. Rock fragments are present to some extent in places, but as a rule they are not very noticeable. Some of the heavier phases of the type are locally called "red clay land." The type as a whole, however, is more typically a loam.

The Upshur loam occurs mainly in Murphrees and Browns valleys, lying adjacent to the Fort Payne stony loam, or, as locally known, the "gray gravelly land ridges." It occurs mainly as a low-lying, flat upland, with the surface varying from flat to gently rolling or occasionally hilly where it extends up the steep slopes of the ridges or adjacent sandstone mountains. The type is quite well drained naturally, some of the flatter portions occasionally needing artificial drainage, which is easily secured by open ditches leading into some near-by natural drainage channel.

The Upshur loam is derived from the weathering of a fine-grained red shaly sandstone which is in places of a calcareous nature. This rock probably belongs to the Rockwood formation of Silurian age, but the close proximity of the cherty and fossiliferous limestones belonging to the Fort Payne chert, Knox dolomite, and Trenton or Bangor limestone often gives character to the soil.

The Upshur loam is a very productive soil, well adapted to the production of the staple crops—cotton, corn, and forage crops. It is probably the best of the upland soil types. Small fruits, vegetables, and orchard fruits also do very well on the lighter, higher, and well-drained areas. This soil is said to respond very readily to fertilizers and good cultural methods. The yield of cotton varies from about one-half to 1 bale per acre, and of corn from 20 to 40 bushels, while large yields of the forage crops are reported. Practically all of the type is under cultivation, some of it having been in use for nearly three-quarters of a century.

The value of the Upshur loam ranges from about $10 to $30 an acre, and little, if any, seems to be for sale. In early days some of the most prosperous plantations in the county were located on this type, and to-day many good farms are found upon it.

The following table gives the average results of mechanical analyses of samples of the Upshur loam:

Mechanical analyses of Upshur loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12115, 12527	Soil	1.2	4,6	5.6	15.4	14.4	33.1	25.2
12116, 12528	Subsoil	1.0	3.8	2.6	8.6	11.5	35.0	37.3

DEKALB CLAY.

The Dekalb clay consists of about 8 inches of grayish-brown loam, or clay loam often containing much silt, underlain to a depth of 36 inches or more with a yellowish-brown to reddish-yellow clay. Both soil and subsoil contain usually from 10 to 40 per cent of small shale fragments. It is locally known as "slate land."

The type is found mainly in the southeastern and southern parts of the county. The surface is usually hilly, often in the form of long ridges, with occasional gentle slopes that are easy of cultivation. The drainage is naturally good, but under the conditions of rainfall the soil maintains a water supply sufficient to sustain the crops in time of ordinary drought.

The Dekalb clay is derived from the weathering of shales belonging to the Coal Measures. This shale is usually fine grained, but occasionally a coarser-textured rock occurs which tends to give a lighter texture to the soil. The color of the shale varies from gray to brown, the gray color predominating.

As a whole, Dekalb clay seems productive. It is fairly well adapted to the production of staple crops, and the higher ridges are well suited to peaches and other orchard fruits. Not much of the type is as yet under cultivation, being forested mostly with oak, hickory, some beech, and pine. It is valued at from $2 to $15 an acre. It responds very well to fertilizers and other manures, and to crop rotation, the subsoil carrying enough clay to be retentive. Under the common method of cropping 10 to 20 bushels of corn and one-fourth to one-half bale of cotton per acre, and fair yields of vegetables, sorghum, and forage crops, are secured.

The following table gives the average results of mechanical analyses of the fine earth of samples of the Dekalb clay:

Mechanical analyses of Dekalb clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12125, 12523	Soil	9.2	8.4	2.1	8.8	12.0	26.5	33.0
12126, 12524	Subsoil	1.7	3.8	1.3	2.7	2.3	20.8	67.1

FORT PAYNE STONY LOAM.

The Fort Payne stony loam consists of about 8 inches of gray very fine sandy to silty loam, carrying 10 to 40 per cent of cherty rock fragments, underlain to a depth of 36 inches or more with a reddish-yellow clay loam, with about the same rock content as the soil. In both soil and subsoil the fragments range from 1 to 10 inches in diameter, and are roughly cubical and angular in shape. The more stony areas are indicated by symbol. The type is locally called "gray gravelly land" or "flint-rock land."

The Fort Payne stony loam occurs exclusively in Murphrees and Browns valleys. The surface is very hilly, forming long narrow cherty ridges, with usually steep sides. The type is well drained naturally, but owing to the abundance of rainfall the lack of moisture in the soil is unusual. On the steeper slopes washing and gullying were noted, but the rock fragments tend to retain the soil, and when assisted by contour ditches or grass cover prevent gullying almost entirely.

The Fort Payne stony loam owes its origin to the weathering of dolomitic limestone and chert, from which the peculiar rock fragments present in both soil and subsoil are derived. These rock strata, which underlie the Coal Measures, have been brought to the surface by the folding and faulting incident to the formation of the Appalachian Mountain system. The area of these exposures is along the axis of the anticlinal folds. The overlying Coal Measure strata became broken apart by the severe tension, forming a break into which streams began to work, eventually removing much of the material and exposing the dolomitic limestone and chert. As a result three distinct soil types peculiar to the Murphrees and Browns valleys were formed, the Fort Payne stony loam being the prevailing type. Much of this type lies as high or higher than the so-called mountain tops on each side.

Of the Fort Payne stony loam only some of the less stony areas are cultivated. It produces the staple crops, though as a whole it is not well adapted to crops requiring much cultivation, owing to the quantity of stones on the surface. At present a large part of it is forested with a natural growth of oak, hickory, walnut, and other hardwood trees, together with some pine. For forestry purposes the type serves very well, the timber furnishing lumber, fuel, fence material, etc. The forests also afford a fair range for cattle, especially where Bermuda grass or Japan clover is seeded in the openings. The higher ridges, by reason of their greater immunity from late killing frosts in spring, are well suited to peaches and other orchard fruits, the difficulty of surface cultivation of the land being not of so much importance as with the field crops.

The staple crops where grown produce well, corn yielding 10 to 30 bushels, cotton one-fourth to three-fourths bale, sorghum 200 to 250 gallons of sirup per acre. Forage plants also yield good returns. The land values range from $2 to $5 an acre.

The following table gives the average results of mechanical analyses of samples of the fine earth of the Fort Payne stony loam:

Mechanical analyses of Fort Payne stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12119, 12519	Soil	3.7	4.0	2.1	9.6	6.8	52.0	21.5
12120, 12520	Subsoil	2.9	4.0	1.3	5.0	8.4	45.0	33.1

HAGERSTOWN STONY CLAY.

The Hagerstown stony clay consists of about 8 inches of black to brownish-yellow loam, underlain by a brown to yellowish-gray sticky clay. Usually fossiliferous bluish-gray limestone fragments, 3 to 20 inches broad and 1 to 8 inches thick, are abundant in both soil and subsoil; massive outcrops of hard, bluish-gray crystalline limestone also frequently break the surface.

This type, which is locally known as "lime land" and "black land," occurs in Murphrees and Browns valleys in long, narrow strips, wherever the Trenton or Bangor limestone crops out. The surface is usually rough, stony, and hilly, consisting of ridges and valley slopes. The surface features favor drainage, but in wet seasons the soil often becomes quite sticky and miry, while in dry weather the soil water is rapidly lost if the surface is allowed to bake.

The Hagerstown stony clay owes its origin to a weathering of the Trenton or Bangor limestone of Silurian age, waters charged with solvent gases and acids having dissolved the calcium carbonate and left behind the relatively insoluble constituents of the rock. The stony character of the soil is due to the fact that much of the residual clay has been carried off by rain wash and stream erosion, thus concentrating the unweathered rock fragments on the surface.

The Hagerstown stony clay is naturally quite productive, but owing to the large quantity of rock fragments and outcrop—indicated by symbol on soil map—but little of it is under cultivation. Some of the easy slopes, where the soil and subsoil are deeper and the proportion of rock outcrop and rock fragments less, are cultivated and give good yields of the staple crops, especially the grasses and other forage crops. The more stony areas are better adapted to forestry than to any other use. They may also be used for pasture, and would be particularly fitted as a range for goats or sheep.

On the less stony areas of this soil corn yields from 10 to 30 bushels, wheat 10 to 25 bushels, and cotton one-fourth to three-fourths bale per acre. The yields of forage crops are also satisfactory. Only a small proportion of the type is in cultivation. The value of this type ranges from $2 to $5 an acre.

The following table gives the average results of mechanical analyses of samples of fine earth of the Hagerstown stony clay:

Mechanical analyses of Hagerstown stony clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12117, 12521	Soil	0.8	5.1	5.0	10.7	5.0	29.0	44.2
12118, 12522	Subsoil	.8	2.8	1.6	5.4	4.0	27.6	57.7

MEADOW.

The Meadow of Blount County includes mainly the first bottom land along streams. In general the soil, to a depth of 8 or 10 inches, varies from dark clay loam to fine sandy loam in texture, while the subsoil, to a depth of 36 inches, consists of a brown clay loam or sandy clay loam. There are areas where the soil is more nearly a clay on the one hand, or a sand on the other, but as a rule the texture lies between the limits of a fine sandy loam and a clay loam.

The areas of Meadow are usually flat and sometimes wet, as in the lower bottoms, but they now and then occur as high or second bottom land, and are, in this case, often slightly rolling in character. The greater part of the type has an elevation intermediate between the high and the low areas. These bottom lands occur very irregularly, varying from mere strips to areas one-third of a mile in width.

Much of the type is subject to overflow during winter, or the rainy season, but when the streams fall to their normal stage, the greater part of the type has ample natural drainage.

The Meadow owes its origin to stream deposition and accumulation of surface wash from the adjoining highlands, and is a very productive soil, carrying much organic matter and being enriched from year to year by deposits left by overflows. It is well adapted to the staple crops, and most of it is under cultivation. The yields of cotton range from one-half to 1 bale per acre, and of corn from 20 to 40 bushels, while the yields of sorghum cane, corn, hay, and forage crops are usually very good.

AGRICULTURAL METHODS.

The production of cotton is the principal interest of Blount County, and the farm operations all hinge more or less on this crop. In preparing the cotton land the old stalks are broken down. Sometimes this is done by hand with a hoe or stick, but a better way in use by many is to drag a log across the fields by means of mules, or to use a knife roller, which not only breaks down the stalks but cuts them into small pieces, thus greatly facilitating plowing. The land is usually broken to a depth of 2 to 4 inches, which is hardly deep enough to give the best results. Cotton is planted in April, usually with a horse-power drill planter which opens up the furrow, drops the seed, and covers it, all in one operation. The planting is usually in rows, more or less ridged up, 3 or 4 feet apart, and, if on hillsides, the rows follow contours to guard against washing and gullying. The contour system of cultivation is very generally followed in the county and is to be commended.

When the cotton plants are three or four weeks old they are thinned out, or "chopped," by hand with a hoe, leaving single plants standing 10 to 20 inches apart in the row. In the meantime, and until the plants bloom, which is usually during the last two weeks of June, the space between the rows is cultivated with a single-horse shovel plow, throwing the soil toward the plants. A two-horse harrow toothed cultivator that will give shallow but thorough cultivation, such as has been found eminently successful in the great corn belts, might be used to advantage on much of the lands of Blount County. Cotton picking extends usually through November and December in about three different pickings. The Russell Big Boll seems to be the favorite variety of cotton grown.

Corn is next in importance, and is grown for home use rather than for market. It is planted in ridged rows and cultivated much the same as cotton. Prior to the full ripening of the grain the leaves are stripped from the stalk by hand, tied in small bundles, dried, and used for fodder for horses and mules and other stock during the winter. When ripened, the ear-corn is removed and the stalks allowed to remain standing to go to waste in the field. Some, however, are beginning to gather the whole plant, as is found profitable in other parts of the country.

Systematic rotation of crops is not general. In the greater number of cases it is a few years cotton, then a few years corn, and then cotton again. However, some are beginning to practice the following crop rotation: First year, cotton, in which may be fall-seeded crimson clover, winter rye or oats to prevent washing and gullying and to serve as winter and spring forage; second year, corn, in which just before the last cultivation cowpeas may be sown broadcast, which may either be used for fall and winter pasture or for hay if desired; the third year, cotton again is planted. As a rule an application of from 200 to 400 pounds of commercial fertilizer per acre is required for cotton. The period during which any one group of crops may be grown may extend through one or more years, depending upon the character of the soil and convenience of the farmer. And again, a period of several years in grass may follow the above two-year rotation scheme. Owing to the mild, short winter, two or three crops may be produced on the same land within the year, as is suggested in this rotation. There is thus greater opportunity for valuable results from rotation of crops and other more or less intensive methods than in other less favored sections of the country.

At present much fertilizer—about $35,000 worth annually—is used, but if more attention were given to crop rotation and to the improvement of cultural methods, a part of this might be dispensed with, or, if used, better results could be obtained.

AGRICULTURAL CONDITIONS.

There exists in Blount County the basis for two great industries—mining and farming. Workable coal, iron, and limestone are often found close together, an ideal condition for the smelter. The mineral resources of the county have not been much developed as yet. The mining operations probably add something to the wealth of the area, and increase the market for farm products somewhat, but in the nature of the case the great bulk of the money invested and received in mining belongs to concerns outside of the county.

The farmers, according to the local standard, are as a rule in a fairly prosperous condition. The average valuation per farm, including land, buildings, equipment, and live stock, according to the Twelfth Census, is about $800. Most of the farmers are white, and about 54 per cent of the farms are operated by the owners. Of the remaining farms, operated by tenants, only about one-sixth are rented for cash, the rest for a share of the crop. The tenant system, it will be noted, has here quite a strong hold, and, as in other places, it is often associated with a kind of farming that impoverishes the land and leads the farmer into debt. It would be better for merchant and purchaser both if their business relations were more on a cash basis. With the introduction of diversified farming and improved methods of cultivation, the system of renting and credit liens against growing crops will probably be changed for the better.

The average size of the farms, according to the last census, is 90.2 acres. On the basis of ownership the average size would probably be about 120 acres, the census figures including as a "farm" each tenant holding, which varies from 20 to 160 acres. There are many farms comprising from 160 to 640 acres, and a few of 1,000 or 2,000 acres. Much larger tracts are held by mining companies. About two-fifths of the area in farms is under some form of cultivation.

The labor conditions are not very good. Most of the labor is white, the negroes being largely engaged in mining and railroading, and in other industries in the towns. Much of the labor on the farm is therefore done by the owner and tenant and their families. The day wage ranges from 50 to 75 cents or $1 a day, without board, while by the month from $12 to $20 is paid. If board is furnished by the employer, the monthly wage is usually from $7 to $12.

The principal farm products of Blount County,[a] basing yields and values on the returns of the Twelfth Census, are: Cotton, 10,000 to 12,000 bales; corn, about 500,000 bushels; dairy products about $150,000; wool, 18,000 pounds; forest products about $50,000; wheat, 50,000 bushels; miscellaneous vegetables, including tomatoes, about $50,000; sweet and Irish potatoes, 30,000 bushels; sorghum cane sirup, 45,000 gallons; orchard products, $10,000; small fruits about $1,000; peas about 8,000 bushels; peanuts, 1,700 bushels. The investment in live stock is about $500,000.

The figures given show that cotton ranks first, corn next, and dairy products third. As pointed out in another connection, it would seem that more attention might be profitably given to live stock, including poultry, and to the growing of crops incident thereto. Then, too, orchard and small-fruit cultivation might be extended with profit, except in localities of low elevation or where the transportation facilities are not good. On the higher ridges and hills peaches can be grown successfully, while on most of the slopes or flat-topped mountains apples and small fruits could be produced in abundance. As far as noted, fruits seem peculiarly free from fungous diseases in this county.

In the discussion of each soil type separately the crops to which each is adapted have been noted, but it is thought desirable to review at this point some of the characteristic crop features of the different types.

The Dekalb sandy loam includes some of the poorest land, but some of it has been improved and made quite productive. Occurring as it often does on the heights bordering deep valleys and on easy slopes on the mountain tops, much of it is well adapted to the growing of peaches and other fruits. Much of it is also valuable for the production of the staple crops. The stony areas are of little use except for forestry and as a range for live stock.

The Dekalb fine sandy loam is an extensive and important highland type very well adapted to the production of staple crops, vegetables, and small fruits, and some areas have the topographic features favorable for peaches and other orchard fruits.

The Upshur sandy loam is a type of relatively limited extent, but strong and productive of the staple crops, small fruits, and, in places, peaches and orchard fruits. The stony areas, as in the case of the Dekalb sandy loam, are fit mainly for pasture and forestry.

The Upshur loam is probably the strongest and the most productive of the upland soils. It is well adapted to cotton, corn, sorghum cane, hay, and forage crops, and, in a few localities, to vegetables, small fruits, and orchard fruits. Most of the type is in cultivation.

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[a] When the census was taken, the county comprised 753 square miles. Since then (in 1901), it has been reduced to 626 square miles.

The Dekalb clay, an extensive type, occurring as "slaty" ridges and rolling highlands, is fairly productive of the staple crops on the more level areas, and on the ridges it is adapted to forestry, orchard fruits, small fruits, and pasture.

The Fort Payne stony loam is the prevailing type of the Murphrees and Browns valleys. Some of it is suited to the staple crops, while much of the more stony or "gravelly ridge" phases is valued chiefly as forest land or as a stock range. Accessible, favorably situated areas might be used for the growing of peaches and other orchard fruits.

The Hagerstown stony clay occurs to a limited extent in the valleys just mentioned, the less stony phase being quite productive of the staple crops, while the greater part is in forest, consisting mostly of red cedar, a valuable wood for telephone poles, posts, and other purposes. The soil is also well suited for wild pasture, and on the higher slopes for orchard fruits. It also often includes limestone outcrops easy to quarry for use in the iron furnaces and for lime burning and other purposes.

The Meadow, or stream-bottom land, is, as a rule, very productive. Owing to liability to overflow in the winter or rainy season, it is adapted chiefly to summer crops like cotton and corn, though such as are usually uninjured by overflow, like grasses, are well suited to the type. The wooded areas afford excellent wild range for live stock.

The transportation facilities are inadequate. Much of the area is from 8 to 25 miles from a railway, and there is no water transportation. Railway lines of the Louisville and Nashville system pass through a part of the western and southeastern sections of the county. In the fall and winter heavy truck wagons, laden with such products as cotton, are frequently seen en route to points on these lines, to Attalla, on the Alabama Great Southern Railroad, distant from the center of the county about 25 miles, and to Birmingham, which lies about 40 miles to the southwest.

The wagon roads are all dirt roads, often rough and hilly, and in rainy weather quite muddy. Fortunately, however, the adjoining counties sometimes have better roads, as has Jefferson, thus affording easier hauling for part of the way for such products as are drawn to Birmingham. The material for making good road beds, such as rock, sand, clay, and gravel, is usually near at hand, and a movement for road improvement is being considered.

The market conditions, being dependent upon the transportation facilities, are not very good for much of the central portion of the county. There is considerable local trading with merchants in the towns and at the numerous crossroads stores of the county, which serve as depositories of bale cotton and cotton seed, whence these are eventually hauled to outside markets. The towns of the county are comparatively small, and consume but little of the farm products, though quite important as depots. Oneonto, the county seat, according to the last census, has a population of 583, and Blountsville 500, while the other towns range from crossroads settlements containing a family or two to villages of 100 or 150 population. The mail service is quite good, through star routes and the gradual extension of rural free delivery, and reaches nearly all parts of the county daily.

The educational facilities of the county consist principally of public schools, but as yet the schools are usually open for but a short term, and with moderate equipment and efficiency. At Blountsville there is a Congressional district school of agriculture, which is the leading educational institution in the county. The indications are that other schools are soon to be established and the existing system made more efficient.

SOIL SURVEY OF MONTGOMERY COUNTY, ALABAMA.

By **W. E. McLENDON** and **CHARLES J. MANN.**

LOCATION AND BOUNDARIES OF THE AREA.

Montgomery County is situated in the south-central portion of the State of Alabama, between 31° 55′ and 32° 30′ north latitude and 86° and 86° 30′ west longitude. It is bounded on the north by the Alabama and Tallapoosa rivers, immediately north of which are Autauga and Elmore counties; on the east by Macon, Bullock, and Pike counties; on the south by Pike and Crenshaw counties, and on the west by Crenshaw and Lowndes counties. The county has an area of 499,328 acres, or about 780 square miles.

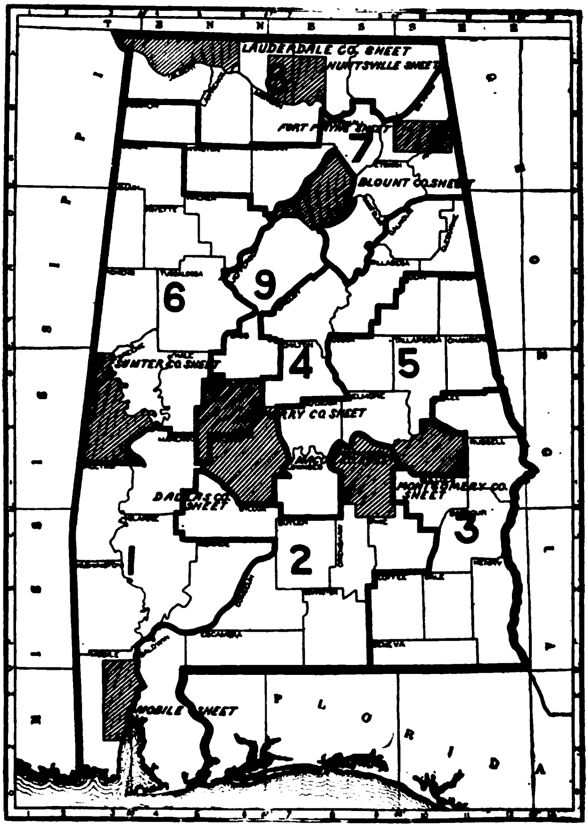

FIG. 17.—Sketch map showing location of the Montgomery County area, Alabama.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Montgomery County was organized in 1816, three years before Alabama was admitted to the Union as a State, but was later reduced greatly in size by the relinquishment of territory which went to form parts of Elmore, Bullock, and Crenshaw counties. The first white settlements in that part of the country now within the county boundaries took place at about the time of the original organization. These settlers came to the present site of the city of Montgomery, which had been prior to that time a trading post. The region about was rich in agricultural resources, and was comparatively accessible because of the Alabama River, a navigable stream, and the development of the region was relatively rapid. By 1821 the town had assumed considerable proportions; by 1835 it had become the most important town in the State, and in 1846 it was selected as the State capital. The surrounding country kept pace with this growth.

Cereals were the first agricultural products of the county, and some live stock was also raised in the early days. About 1850 the cotton production in the State centered around Montgomery and the agricultural wealth of the community reached a high stage, which was brought to a temporary halt by the civil war. Although the change in the economic conditions following the war hampered for a while all agricultural operations, the recovery in this part of the State was comparatively rapid. Cotton still forms the all-important product of the farm, but more diversified farming is coming into favor and holds out the hope that the one-crop system so long in vogue will before many years give way to what nearly all are ready to admit is the more rational plan of husbanding the resources of the soil.

CLIMATE.

The climatic conditions of the area are very favorable to all of the crops now grown, and would prove equally as favorable to numerous others that have not yet been introduced. The summers are long and warm and the winters short and mild, except for occasional cold snaps when the temperature may go as low as 8° to 10° F. The snows are light and do not occur every winter. In the summer months the temperature sometimes goes above 100° F. July is the hottest and January the coldest month of the year.

The following tables were compiled from records of Weather Bureau stations at Montgomery and Union Springs. The latter place is in Bullock County, but it was included in order to show that practically the same conditions prevail over a large section.

Normal monthly and annual temperature and precipitation.

Month.	Montgomery.		Union Springs.		Month.	Montgomery.		Union Springs.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	° *F.*	*Inches.*	° *F.*	*Inches.*		° *F.*	*Inches.*	° *F.*	*Inches.*
January	48.3	5.37	45.6	4.88	August	79.8	4.13	80.4	4.85
February	52.7	5.34	48.6	6.90	September	75.6	2.95	75.6	2.84
March	57.0	6.47	56.0	6.34	October	65.2	2.36	65.0	3.34
April	65.4	4.80	65.4	3.67	November	55.2	3.88	56.2	2.50
May	72.8	4.05	73.8	3.16	December	49.6	4.67	46.5	4.14
June	79.4	4.67	80.7	4.31	Year	65.2	52.72	64.6	52.24
July	81.5	4.53	81.2	5.31					

Dates of first and last killing frosts.

Year.	Montgomery.		Union Springs.		Year.	Montgomery.		Union Springs.	
	Last in spring.	First in fall.	Last in spring.	First in fall.		Last in spring.	First in fall.	Last in spring.	First in fall.
1896	Mar. 21	Nov. 9	Mar. 20	Nov. 9	1900	Mar. 2	Nov. 9	Mar. 16	Nov. 8
1897	Feb. 28	Nov. 4	Feb. 28	Nov. 29	1902	Mar. 18	Nov. 28	Mar. 18	Nov. 28
1898	Feb. 23	Oct. 23	Mar. 5	Oct. 27	1903	Feb. 19	Nov. 18	Feb. 22	Oct. 25
1899	Mar. 29	Nov. 6	Mar. 5	Dec. 3	Average	Mar. 8	Nov. 9	Mar. 8	Nov. 14

The average dates of last killing frost in spring and first in fall for Montgomery are given as March 8 and November 9, respectively.

The rainfall is sufficiently heavy to produce maximum yields of any of the crops grown, but the occurrence of occasional droughts cut some of them short. This condition would not be so marked if the farmers would give more attention to the tillage of their lands so as to conserve the moisture. In places there is also need of better drainage to provide against wet seasons, which are often more disastrous than droughts.

PHYSIOGRAPHY AND GEOLOGY.

The general physical divisions of the county consist of the level to rolling, and, in places, high uplands, and the stream valleys, which here will be made to include only the first and second bottoms. The principal valley lands are those of the Alabama and Tallapoosa rivers. At Montgomery the Alabama River has cut back into the highlands, but to the east and west of this point the river plains widen out, reaching a general width of 2 to 5 miles. A small part of these lands constitutes the river flood plains, being subject to annual overflows. These are most extensively developed along the Tallapoosa River just east of the confluence with the Coosa River, forming the Alabama. The second bottoms are from 15 to 60 feet higher, and are no longer subject to overflows, except in local areas during extremely high floods. Here the surface is level, except for such unevenness as is produced by occasional secondary terrace lines, small stream depressions, and remnants of higher lands. In places the surface is so level that drainage is very poor. These river lands are bordered on the south by the highlands, in a bold bluff line, most of the way, from 30 to 100 feet high. This bluff line is best developed east of Montgomery. All of the creeks of any size have similar but smaller valleys with comparatively wider overflow strips. The second bottoms are not bordered by bold bluffs, but usually by slopes that can be used for agricultural purposes. The extent of all the valleys, as described above, is outlined in the Meadow lands and the soil types are described as alluvial. The difference in elevation between the lowlands and the highlands ranges from 10 to about 200 feet, greater differences occurring in the broken, hilly areas.

The surface features of the uplands vary principally with the different geological divisions, the most important of which is the rotten limestone or Selma chalk belt. This belt crosses the county in a general easterly and westerly direction, passing just to the south of Montgomery and extending to within a short distance of Ramer and Pinelevel. The northern half of this area comprises the greater part of what is known as the "black prairie belt." The surface here is level to gently rolling, with a relief of 20 to 40 feet from ridges to stream troughs. The southern half comprises the principal areas of the "redoak prairie" or "post-oak prairie" lands, being somewhat higher and more rolling than the black prairie belt. Along the southern border of the region the surface is rather badly broken and in places not fit for agricultural purposes.

Bordering the prairie from the south is the Strata Ridge, which is a continuation of the Chunnenugga Ridge of Bullock County. It is the divide between streams flowing north and those flowing south. To the north the streams are much the lower and have cut back into this ridge at about base level. The result is a very badly gashed and broken strip of territory with local differences of elevation of 75 to 150 feet. The more broken areas are fairly well represented in the soil map by the large areas of Orangeburg sand. To the south the slope is almost imperceptible, and the general surface is fairly level, except in the vicinity of some of the larger streams, where erosion has been excessive. Immediately along the southern boundary of the county is another strip, parts of which are considerably higher and more hilly than the more level areas referred to above.

Beginning at Montgomery and extending to the eastern edge of the county is a belt of land which divides the river plains and the prairie lands. Its general width is from 2 to 3 miles. This area is rather badly broken around Montgomery and probably a little higher than the prairie, but farther east it becomes more nearly level and bears evidence of being the highest terrace left by the Tallapoosa River, as there are a number of secondary terraces, all of which are lower than the broken areas and the prairie lands on the south. Two miles west of Klondike is a remnant of the same kind with a very much broken surface. It is much higher than the adjoining prairie and alluvial lands.

The highest elevations in the county are attained in the Strata Ridge and in the broken area just referred to. The highest points here are between 500 and 600 feet above sea level; the river plains are 100 to 200 feet.

The county has two distinct drainage systems. One comprises the Alabama River and Tallapoosa River, with Pintlalla, Catoma, and Line creeks and many other smaller tributaries, and affords drainage as far south as the Strata Ridge. The other consists of the creeks flowing south from this ridge, among which Chester, Blue, and Greenbrier creeks are the principal streams. The Alabama River is navigable as far north as Montgomery.

The whole of the area under consideration is within the geographic province known as the Coastal Plain.[a] Consequently all of the soils are of sedimentary origin, derived either directly from these ocean sediments or from these reworked and modified by stream action. At the close of the Cretaceous period the surface formations consisted of the Eutaw sands, which now form the substratum of the northern tier of townships; the Selma chalk, which gives rise to the black prairie soils, and also forms the substratum of the red prairie lands, and the marly sands, jointed clays, blue micaceous marls, and argillaceous limestones of the Ripley group, now buried from 10 to 25 feet by sands and sandy clays of a later age. During Pliocene Tertiary all of the foregoing formations were buried from a few to 30 feet by a mantle of gravel, sands, and sandy clays. This is known as the Lafayette formation, and is extensively developed throughout the Coastal Plain. Subsequently to the deposition of this mantle vast changes in the surface features have taken place. The stream valleys have been carved out and large areas of alluvial lands built up from the eroded material. Of the alluvial lands, the first bottoms are of recent origin, while it is thought that the second bottoms date back to Pleistocene or post-Tertiary. The third and highest terrace left by the Tallapoosa River comprises the greater part of the red-land belt east of Montgomery, and it probably was built up at the close of the Pliocene, which gave rise to the Lafayette mantle. Its appearance is very much the same as the true Lafayette formation, the exact origin of which is not known. The broken area west of Klondike is a remnant of the Lafayette mantle. It is probable that at least a veneering of these sands covered the prairie belt, but if such was the case they have been about all removed by erosion. As a result the Selma chalk gives rise to the soils of the black prairie and also forms the substratum of the red prairie at a depth of 2 to 10 feet. The overlying clay of the red prairie is of a very heavy, sticky character, and has the appearance of being a transition deposit between the deep-water chalks and the shallow-water deposits of sandy clays. South of the prairie belt the material is more generally typical of the true Lafayette mantle, but here and there are areas of soils modified as a result of erosion. In places the heavy clays of the Ripley formation are exposed, giving rise to a piney-woods phase of the Susquehanna clay.

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[a] The main facts stated in the discussion of geology are drawn from Dr. Eugene A. Smith's report on the geology of the Coastal Plain of Alabama.

The Selma chalk, which in reality is an impure argillaceous limestone, has been proved to be an excellent material for cement making. It is easy to mine and occurs in exhaustless quantities. The amount of calcium carbonate ($CaCO_3$) ranges from 60 to as much as 85 per cent. At present no attention is being given to the cement industry in the county.

In order to get water fit for domestic purposes in the prairie belt it is necessary to sink wells below the chalk formation, which at Snowdoun is something over 300 feet thick.

Clays fit for brick making are found all through the second bottom lands and in a few places in the southern part of the county.

SOILS.

Sixteen types of soil were recognized in this survey. Their names and relative and actual extent are given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cept.
Susquehanna clay	129,844	25.9	Congaree clay	11,712	2.4
Houston clay	86,400	17.3	Meadow	10,944	2.1
Yazoo clay	50,624	10.2	Norfolk fine sand	9,856	1.8
Norfolk fine sandy loam	39,552	8.1	Susquehanna gravelly loam	7,424	1.5
Norfolk clay	33,856	6.8	Orangeburg fine sandy loam	6,208	1.2
Congaree loam	33,856	6.8	Norfolk sand	4,288	.9
Norfolk sandy loam	32,896	6.6	Norfolk gravelly loam	1,536	.3
Orangeburg sandy loam	22,912	4.5	Total	499,328	
Orangeburg sand	17,920	3.6			

NORFOLK SAND.

The Norfolk sand, to a depth of 3 to 6 inches, consists of a gray medium to coarse sand, underlain to a depth of 3 or more feet by a reddish sand of about the same texture as the surface soil. Both soil and subsoil are slightly loamy, and seem to retain moisture better than the Norfolk fine sand occurring in rolling areas in the southern part of the county.

The areas of the Norfolk sand occur in the northern part of the county. Their surface is level to gently undulating, and they owe their origin to overflow deposits of the Alabama and Tallapoosa rivers when these streams flowed in channels at higher levels. The drainage conditions are satisfactory.

The native forest growth on the Norfolk sand consists chiefly of shortleaf pine and black-jack oak. Where the sand is very deep the trees are inclined to be scrubby.

The Norfolk sand is one of the principal truck soils of the Atlantic seaboard, but it is not used for this purpose in Montgomery County. Cotton and corn are the principal crops. Cotton yields from one-eighth to one-half bale per acre with the use of manures and commercial fertilizers. Corn rarely yields more than 10 bushels per acre. These yields are exceeded somewhat when areas are first brought under cultivation, but the humus in the soil is soon reduced and the yields decline accordingly.

No analyses were made of this type of soil.

NORFOLK FINE SAND.

The soil of the Norfolk fine sand consists of 3 to 6 inches of a light-gray incoherent fine sand, deficient in humus, except in the virgin state. The subsoil, to a depth of 3 or more feet, is a yellowish fine sand of the same texture as the soil.

This type is found in one area of several square miles in extent, and in a number of smaller areas, all in the southern part of the county. It is associated with the Norfolk fine sandy loam and Norfolk sandy loam, and in some of the smaller areas is of alluvial origin. The small area is secs. 33 and 34, T. 12, R. 19, as well as the larger areas, is of the same origin and topography as the adjoining Norfolk sandy loam. The surface varies from comparatively level to rolling. The drainage is good.

The principal crop is cotton, which is not grown without the use of commercial fertilizers. Cotton yields from one-eighth to one-half bale, and corn from a nominal amount to 10 bushels per acre.

By incorporating large amounts of organic matter, either in the form of well-rotted leaf mold, stable manure, or leguminous crops plowed under, this could be made an excellent truck and melon soil. By the same means the crops now grown could be made to give much larger and more remunerative returns, as is the case when the soil is first brought under cultivation.

The average results of mechanical analyses of this soil are given in the following table:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12545, 12547.......	Soil	0.4	8.7	14.9	57.1	6.9	7.2	4.6
12546, 12548.......	Subsoil.....	.8	9.1	15.8	55.0	6.6	6.4	7.2

NORFOLK GRAVELLY LOAM.

The Norfolk gravelly loam, to a depth of 9 to 18 inches, is a gray to brownish sandy loam, carrying from 10 to 40 per cent of waterworn crystalline gravel from one-half inch to 2 inches in diameter. In spots the soil is very gravelly, while in others it is little else than the underlying gravelly clay exposed by erosion. The subsoil to a depth of 3 or more feet consists of a yellowish-brown to brick-red clay, which is generally very gravelly, an absence of gravel being noticed in only a few of the smaller areas.

The type is of very limited extent and is found only in the northern part of the county. Its greatest area occurs on the rough hillsides and knolls of a high broken area 2 miles west of Klondike, in T. 16, R. 16. Smaller areas are found to the north and east of Montgomery.

The small area in the northwestern corner of section 30, T. 17, R. 18, is comparatively level, and derived from river-deposited material, but the other areas have been formed by the denudation of gravel deposits, the same as those underlying the Orangeburg sandy loam at various depths. The topography of these areas is hilly to broken and the surface in places subject to excessive erosion.

The rough and very gravelly nature of the Norfolk gravelly loam renders a large part of it undesirable for agricultural purposes, and less than half of it is under cultivation. Here cotton is the principal crop, yielding from one-eighth to one-half bale per acre, with the use of commercial fertilizers.

On account of the extremely variable character of this soil no samples were collected for mechanical analyses.

NORFOLK SANDY LOAM.

The Norfolk sandy loam consists of 3 to 6 inches of a light-gray medium to fine sand of a slightly loamy nature, resting usually upon a yellowish sand of the same texture to a depth of 12 to 30 inches, where the gradation is into a yellowish-brown mottled clay. The mottled character of the clay generally becomes more intensified with depth to below 3 feet. The average depth to clay is from 15 to 18 inches. The soil is deficient in humus, except in newly cleared and low-lying areas. Its low humus content makes it more droughty than ordinarily would be expected of a soil of its class. In the older settlements it is considered a poor soil and is not farmed to any extent without the use of commercial fertilizers.

The principal areas of Norfolk sandy loam are found in the southern tier of townships of the county, where it occupies level to gently rolling topography. Drainage is good on the higher levels, but the large level areas and numerous small depressions are poorly drained. Some of the lower hillsides are kept springy a large part of the year by seepage waters from the higher lands. Some of these wet areas are unfit for agricultural purposes, while the crops grown on others are very uncertain. Such lands could be profitably improved by drainage.

A part of the area just across Chester Creek from Centerpoint is intermediate in texture and depth between the typical Norfolk sandy loam and the Susquehanna gravelly loam. This area is well drained and produces good crops. Immediately around Centerpoint is a flatwoods area, a large part of which is not used for agricultural purposes on account of poor drainage conditions.

In the southern part of the county the Norfolk sandy loam is a sedimentary soil derived very largely, if not entirely, from the Lafayette of Pliocene Tertiary. There are local outcrops of the Cretaceous clays which give rise to variations in the soil, but as a rule these are buried 20 to 50 or more feet deep. The smaller areas in the northern part of the county are derived from old alluvial deposits, with the exception of the area south of Waugh, the origin of which is the same as the adjoining Orangeburg sandy loam. A very large part of this type is under cultivation, cotton being the principal crop. Corn is grown in a more limited way, but as far as possible it is confined to new lands and the more loamy areas. The general yield of cotton is from one-fourth to three-fourths bale per acre. Large yields are obtained where the land has been systematically fertilized for a number of years. Corn will yield anywhere from 5 to 25 bushels per acre. There is a small acreage in oats, but the yields are light, except where heavily fertilized. It is an excellent peach and truck type.

The average results of mechanical analyses of typical samples of this soil are given in the following table:

Mechanical analyses of Norfolk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12554, 12556	Soil	0.4	6.9	8.7	51.8	12.7	11.4	7.9
12555, 12557	Subsoil	.4	4.7	5.6	39.9	11.2	10.9	27.1

NORFOLK FINE SANDY LOAM.

The surface 4 to 6 inches of the Norfolk fine sandy loam is a light-gray fine loamy sand to fine sandy loam, relatively low in organic matter. Below this is a yellowish fine sand, reaching to a depth of 12 to 24 inches, where it gives way to a yellowish-brown fine sandy clay which may be mottled with darker or lighter colors. The tendency to mottle generally increases with depth to below 3 feet. This soil when first brought under cultivation is of a dark-gray color and of a loamy nature, but after cultivation to cotton or corn for a few years a large part of the organic matter disappears, and as a result the color changes to a light gray, approaching white in places, and the soil becomes more compact and less retentive of moisture. This is one of the principal reasons why the crop yields are so much smaller after the first few years of cultivation.

The Norfolk fine sandy loam is found in all parts of the county occupying second terrace lands along the creeks and smaller stream courses. It also occurs in considerable areas in the higher terraces of the Alabama and Tallapoosa river valleys.

The topography of the areas of Norfolk fine sandy loam is level to gently undulating, and all through the type are small spots and strips that, as a result of poor drainage outlets or of seepage from higher lying areas, are wet and unfit for cultivation. All such areas are susceptible of improvement by providing adequate drainage. The higher lying areas are naturally fairly well drained.

With the exception of a few areas which are derived directly from the Lafayette, the Norfolk fine sandy loam has been formed from a Pleistocene alluvial deposit, representing what was once the bottom lands along the streams. The few areas found along the southern border of the county and in T. 13, R. 17, are usually more rolling than that of the main areas, but the color and texture of the soil are about the same in both cases.

A very large part of the Norfolk fine sandy loam is under cultivation, cotton and corn being the principal crops. Except in newly cleared areas these are rarely grown without the use of manures and commercial fertilizers. Cotton yields from one-fourth to 1 bale per acre. The higher yields are obtained only on new lands and on old lands that have been systematically fertilized for a number of years. New lands will yield as much as 25 bushels of corn per acre, but 10 bushels per acre would represent more nearly the average yield of older lands.

A well-planned system of rotation should be practiced on this soil in order to keep it more abundantly supplied with humus.

The average results of mechanical analyses of representative samples of this soil are given in the following table:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Veryfine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12550, 12552.......	Soil	Trace.	1.0	3.1	47.8	20.6	18.1	8.9
12551, 12553.......	Subsoil.....	0.1	.6	1.5	35.9	13.5	17.2	31.1

ORANGEBURG SAND.

The Orangeburg sand, as mapped in Montgomery County, is somewhat an anomalous type on account of the hilly to broken topography occupied, which consists very largely of narrow stream divides and hills, with broad and narrow intervening stream depressions, the slopes ranging from 10° to 45° and the depth of the depressions from 50 to 100 feet.

Typically the Orangeburg sand is a light-gray medium sand, 4 to 6 inches deep, underlain by a light-yellowish sand, extending to a depth of 15 to 36 inches. Below this is a reddish-brown to brick-red sandy clay, which in places contains considerable mica. The line between soil and subsoil is usually sharply defined. At a depth of 20 to 50 feet the clay generally gives way to strata of laminated clays and rotten limestone. When first brought under cultivation the soil contains a good supply of humus, but a large part of this disappears after a few years' cultivation.

Some of the hills and ridges are capped by small areas of sand over 3 feet deep, while on the hillsides may be a gradation from an almost pure sand to a light sandy loam, underlain by clay at a depth of 12 to 18 inches. Often just the reverse is true. On the lower slopes other modifications may occur as a result of exposures of limestone and calcareous clays. Here and there through the type are also small areas of Susquehanna clay that, owing to their limited extent, could not be shown on the accompanying map.

In the northern part of the county is another phase of the type which is of alluvial origin and occupies nearly level topography. The soil here is a gray to brownish sand 4 to 6 inches deep, underlain by a reddish-brown sand to a depth of 15 to 36 inches, below which is a friable brick-red sandy clay.

The largest development of the Orangeburg sand is in the southern part of the county along the border line between the main prairie belt and the sandy region to the south. Beginning at the eastern edge of the county and passing just to the north of Pinelevel and on the west to the north of Ramer is the largest area. Smaller areas are found near the southwestern boundary of the county.

In general, the formation giving rise to this type lies from 50 to 100 or more feet higher than the adjoining areas of Susquehanna clay. The streams through the prairie have cut back into this formation practically at base level. As a result the topography is hilly and in places so broken as to make the soil unfit for agricultural purposes. The general boundary between this soil and the Norfolk sand and Norfolk sandy loam is marked by an abrupt bluff.

The drainage is good, except an occasional small area on the lower slopes where seepage from higher levels keeps the soil continually wet.

Except the alluvial areas referred to above, the Orangeburg sand represents broken sandy areas of the Lafayette mantle where the underlying sandy clay is red and comes within 3 feet or less of the surface.

The original forests consisted of several varieties of oak, hickory, chestnut, poplar, sweet gum, and many other deciduous trees, besides a scattering growth of shortleaf pine.

About half of the Orangeburg sand is under cultivation, and the slopes are as generally used as the leveler areas. Cotton yields from one-eighth to three-fourths bale per acre, and corn from 5 to 20 bushels per acre. The corn crop is more generally confined to the loamy areas along the small streams. Commercial fertilizers are used by all of the farmers. This soil would probably prove well adapted to peaches, as the broken topography would serve as a protection against cold winds and late spring frosts.

The average results of mechanical analyses of samples of this soil are given in the table following.

Mechanical analyses of Orangeburg sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12562, 12564	Soil	Trace.	8.7	22.6	53.1	4.8	4.9	5.6
12563, 12565	Subsoil	0.1	6.8	18.0	43.1	4.3	4.3	28.3

ORANGEBURG SANDY LOAM.

The Orangeburg sandy loam, or "red lands," as it is locally called, is a brown to reddish-brown light sandy loam 4 to 15 inches deep, resting upon a very friable brick-red clay with a depth of 3 or more feet. The average depth of the sandy loam covering is limited by the usual depth of plowing, 4 to 6 inches, and, as a result of continuous cultivation to the same depth, the upper surface of the subsoil has packed into a plowsole in many places.

The humus content of the soil is usually low, except in some of the small depressions, where there has been an accumulation of vegetable remains by local wash. Some of these small depressions represent more nearly the true Orangeburg loam, but they were too small to be mapped separately. Below 3 feet the subsoil clay may alternate with layers of gravel and sand, or may remain of about the same texture to a depth of 30 or more feet.

The Orangeburg sandy loam is found only in the northern part of the county. The largest areas extend from Montgomery in an almost continuous strip to the eastern edge of the county. Smaller areas are found to the north of this strip and to the west of Montgomery.

Immediately around Montgomery the surface is rolling and in places badly cut up by washes and gorges, but farther east it is more nearly level. The principal unevenness is produced by small winding depressions and secondary terrace lines. Some of these areas are higher than others, but within themselves are nearly level. All of the smaller areas are fairly level. The drainage of the type is good, except in a few small depressions.

The age of the formation giving rise to the Orangeburg sandy loam is not definitely known. The more level areas east of Montgomery have the topography of a river terrace, and it is quite probable that they occupy parts of the highest terrace left by the Tallapoosa River. These areas in general are lower than the prairie belt to the south and border it in a fairly well-defined terrace line to within about 4 miles of Montgomery on the east. From this point westward there is an area more nearly typical of the materials of the Lafayette formation, as are the high small areas about 3 miles west of Klondike. Some of the smaller areas associated with the Norfolk clay are remnants of higher lands, while others are old alluvium.

Practically all of this type is under cultivation, and is highly prized for the production of cotton. The yields are not as high in some instances as on the Houston clay and other prairie types, but it is considered a safer soil from year to year than the prairie type. Cotton yields from one-half to 1 bale per acre. As much as 1½ bales per acre has been produced where the land is heavily fertilized. Very little corn is grown, as it is claimed that the yields are generally light, many of the farmers holding that it is more economical to grow cotton and buy corn. The difficulty here, as with the Orangeburg fine sandy loam, is that the soil proper is shallow, and in many places underlain by a plowsole, which is locally referred to as hardpan. This combination makes a droughty soil, a condition, however, which can be remedied by deeper and more thorough plowing and by giving more attention to a system of crop rotation that will increase the organic content of the soil. No doubt this soil can be made to produce good corn crops. It is an excellent peach soil. In other parts of the South it is being used for the production of a good grade of tobacco, and it is probable that this crop could be successfully grown here.

The average results of mechanical analyses of representative samples of this type are given in the following table:

Mechanical analyses of Orangeburg sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12161, 12566	Soil	2.5	20.6	14.8	23.8	10.4	15.9	11.6
12162, 12567	Subsoil	1.9	11.4	9.3	14.2	6.1	22.2	34.5

SUSQUEHANNA GRAVELLY LOAM.

The Susquehanna gravelly loam, or "red gravelly lands," is a grayish-brown fine sandy loam, with a depth of 6 to 12 inches, resting upon a yellowish, reddish-brown or red clay subsoil that extends to a depth of 10 or more feet. The soil contains varying amounts of gravel and stone up to as much as 40 or 50 per cent, the maximum occurring around some of the washed knolls and slopes, but generally there is not enough seriously to interfere with agricultural operations. The gravel consists of angular and subangular fragments of ironstone, the general run of which are from one-half to 1 inch in diameter. Much larger fragments may be expected around the more gravelly areas and here and there throughout the type. A less amount of gravel is found in the subsoil, where it may occur scattered through the clay or in one or more well-defined layers, which in places form a hardpan. These layers, when exposed to the surface, usually crumble down very much the same as a shale, and the disintegration of just such strata to a large extent accounts for the gravel now found in the soil. The subsoil material is a highly ferruginous clay, as is evidenced by its tendency to consolidate.

The Susquehanna gravelly loam is of limited occurrence and is found only along the southern border of the county.

The topography is rolling to hilly and in a few places too broken to allow agricultural operations. The natural drainage is good. This soil generally lies at a much higher elevation than the adjoining Norfolk sandy loam, but a few of the more level areas have about the same elevation. Where typically developed it is a sedimentary soil derived from the Lafayette formation, but as all of the areas are underlain at a depth of 10 to 30 feet by strata of laminated clays, bluish micaceous marls, and marly clays of the Ripley group, these materials have been exposed on many of the hillsides, causing some variation in the soil.

Cotton is the principal crop. With the use of commercial fertilizer the yields range from one-fourth to three-fourths bale per acre. Corn yields from 5 to 25 bushels per acre. Wherever possible the corn crop is confined to the alluvial strips along the small streams.

The average results of mechanical analyses of samples of fine earth of this soil are given in the following table:

Mechanical analyses of Susquehanna gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12541, 12543	Soil	2.0	5.9	4.8	26.1	20.2	21.7	19.1
12544, 12542	Subsoil	1.7	4.7	3.2	18.8	9.1	17.3	45.1

ORANGEBURG FINE SANDY LOAM.

The Orangeburg fine sandy loam is a yellowish or brownish-gray fine sandy loam, 4 to 12 inches deep, underlain by a red or reddish-brown fine sandy clay. The surface 4 to 6 inches constitutes the soil proper, and generally the amount of organic matter carried is not sufficient to make it a good absorber and retainer of moisture.

The Orangeburg fine sandy loam is of limited extent and, with the exception of a few small areas in the southern part of the county, it is found north of the prairie belt, which passes just south of Montgomery.

The areas of Orangeburg fine sandy loam, associated with the Norfolk clay, are of alluvial origin, but those associated with the Orangeburg sandy loam east of Montgomery are at a higher level and represent an intermediate type between the Orangeburg sandy loam and the Susquehanna clay. In the southern part of the county the type is between the Norfolk sandy loam and the higher areas of Susquehanna gravelly loam in topography and texture. In general the surface is level to gently rolling and the drainage is good.

Cotton is the principal crop grown on the Orangeburg fine sandy loam. The yields range from one-fourth to 1 bale per acre, depending upon the amount of fertilizers used and the methods of cultivation. It is not considered a good corn soil, and as a result not much is planted. Corn yields from 10 to 20 bushels per acre. It is said that the shallow depth to clay, which many farmers designate as hardpan, makes the soil too droughty for corn. This is doubtless so, but the conditions complained of could be overcome by more thorough plowing, including subsoiling, and when this is done the type should produce fine yields of corn.

The average results of mechanical analyses of samples of this soil are given in the following table:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12568, 12570	Soil	0.2	5.6	13.1	26.9	18.7	25.0	10.1
12569, 12571	Subsoil	.1	3.2	7.6	19.2	12.0	22.2	35.5

CONGAREE CLAY.

The Congaree clay, to a depth of 8 to 12 inches, is a brown loamy clay containing considerable organic matter, and locally becoming somewhat sandy at the surface. When wet this is a very mellow soil, but on drying it cracks badly and becomes hard and harsh. Because of its tendency to crumble into small granules it is often referred to as "buckshot land." The subsoil to undetermined depths is a silty clay, ranging in color from yellow to brown; the darker colors are found where the deposits have been laid down more recently. This type of soil was mapped in the adjoining county of Macon as the Ocklocknee clay, but a further study of its characteristics suggests that it is more properly correlated with the Congaree soils.

The Congaree clay constitutes the overflow lands of the Alabama and Tallapoosa rivers. Parts of the type are overflowed and receive fresh deposits every year, but some of the higher ridges only during the larger freshets. The surface is level to gently undulating. Some of the depressions are too wet to be used for agricultural purposes.

The Congaree clay is considered a very strong agricultural soil, and about half of the type is under cultivation. Hay, corn, and cotton are the crops grown. Johnson grass, which gives yields of one-half ton to 2 tons per acre, is the principal hay crop. Corn will yield from 20 to 50 bushels and cotton from one-half bale to 1¼ bales per acre. These crops are uncertain on account of wet seasons and overflows.

The following table gives the average results of mechanical analyses of representative samples of this type:

Mechanical analyses of Congaree clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12163, 12572	Soil	0.1	0.3	0.4	7.1	10.2	44.3	37.2
12164, 12573	Subsoil	.1	.3	.3	5.4	9.9	41.4	42.6

HOUSTON CLAY.

The Houston clay, to a depth of 6 to 15 inches, is a very fine grained dark-gray to black clay, containing large quantities of small lime concretions and in places small shells. When wet it is very sticky and hard to handle, but when moist it is soft and friable and possesses a good granular structure. It does not bake and pack after a rain, but on drying cracks to some extent and later breaks down into a loose mulch. It is a good retainer of moisture, except in the lighter colored areas, which are deficient in humus. The subsoil is a chalky, white to light-drab highly calcareous clay, or "rotten limestone," as it is more generally called. In places the original jointed or shaly structure is still retained, while in others, to a depth of 4 to 10 feet, it has weathered down into a massive chalky looking material. All through this are numerous lime concretions which are generally soft and chalky. Below 10 feet are alternating layers of bluish and white marly clays which also possess the jointed or chalky structures referred to above.

All through the areas of Houston clay are light-gray or drab colored areas where the soil is little different from the subsoil. These areas occur in nearly every field of any size and are generally the result of erosion. The soil here is deficient in organic matter and more droughty than the darker colored soil. From this extreme there are many intermediate variations, both in color and depth of the soil, to the very black areas with a soil 15 inches deep. Here and there throughout the type are also local areas of Susquehanna clay. The occurrence of these minor variations was such that they could not be shown on the accompanying soil map.

When spoken of as a whole the Houston clay is called "black prairie" or "black belt," but there are in general use several other specific names which are generally based on color, as "white prairie," "gray prairie," "black prairie," and "red prairie." The last name is applied to the small areas of Susquehanna clay which are found in nearly every field.

The principal areas of the Houston clay are found in the northern half of the county, forming a broad but interrupted belt which crosses the county in an easterly and westerly direction, and passes just to the south of Montgomery. A few smaller areas are found to the south of this belt. Those in T. 13, R. 17, are more generally of a light-gray color and represent a phase of the type. The occurrence of this phase of the type in Montgomery County was generally such that it was considered best not to attempt a separate classification.

The surface of the areas occupied by the Houston clay ranges from nearly level to rolling. In places the slope is sufficient to subject the fields to erosion when left bare. The type is traversed by numerous small streams, which flow through broad, shallow depressions and afford excellent surface drainage.

As may be inferred from the above, this is a residual soil derived from a very impure Cretaceous limestone. Some parts of this type have not been forested within the memory of man; others originally supported forests of post oak, hickory, hawthorn, wild plum, ash, etc.

Nearly all of the Houston clay is under cultivation. Cotton and corn are the principal crops. Some oats and considerable hay are grown for use on the farm and to supply the local market. A few farmers are devoting at least a part of their time to stock raising and dairy farming. Johnson grass is the principal hay crop, but *Melilotus alba*, or sweet clover, which makes a luxuriant growth, is also used to some extent for this purpose. Bermuda is the principal pasture grass. Very little alfalfa is grown, but it has proved well adapted to this soil when given the proper care. Cotton yields from one-third to 1 bale per acre, corn 15 to 50 bushels per acre, oats 20 to 60 bushels per acre, and hay from one-half ton to 2 tons per acre. The lighter colored areas, as a rule, do not produce as good crops as where the soil is darker colored and deeper.

Some areas of this soil have been under cultivation for at least seventy-five years and are still producing good crops. Others have become less productive, and as a result have been thrown out of cultivation, or commercial fertilizers have been resorted to in order to increase the yields. It is a noticeable fact that nearly all of these so-called worn-out lands contain only a small amount of organic matter. Instead of trying to continue to farm them to cotton, they should be planted in Melilotus or alfalfa and allowed to remain in crops of this character until the right proportion of organic matter has again been incorporated with the soil.

The Houston clay offers exceptionally good opportunities for forage crops, stock raising, and dairy farming. In the cotton and corn lands Johnson and Bermuda grasses have become a very serious pest. Many fields have been abandoned to Johnson grass, which is generally cut for hay, in many instances giving better returns than when the land was used for cotton and corn.

The average results of mechanical analyses of samples of this soil are given in the following table:

Mechanical analyses of Houston clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12151, 12585	Soil	0.5	1.3	1.3	6.0	6.6	41.6	42.4
12152, 12586	Subsoil	Tr.	.3	.4	3.5	4.9	28.8	61.9

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12585, 28.79 per cent; No. 12586. 45.17 per cent; No. 12151, 40.80 per cent; No. 12152, 66.20 per cent.

YAZOO CLAY.

The Yazoo clay, to a depth of 6 to 9 inches, is a dark-brown to black clay or clay loam, containing very little material coarser than fine sand. The soil is very sticky and plastic when wet, but on drying it cracks and crumbles very much the same as the western adobe soils, for which reason it is often referred to as "buckshot land." Under cultivation it possesses a coarse granular structure which is not destroyed by rains, and if kept mulched it will retain moisture within a few inches of the surface during prolonged droughts. Ordinarily it can be reduced to a good friable mulch, but if plowed too wet in the spring it retains a harsh, cloddy structure for the remainder of the season. There is always an abundance of organic matter in the soil, even where it has been under cultivation for fifty or more years. The subsoil to a depth of 3 or more feet is a heavy plastic clay, varying in color from a gray and brown, mottled in the larger areas, to a dark-brown or black in some of the smaller areas.

The Yazoo clay includes the greater part of the alluvial overflow lands through the black prairie or Houston clay belt. A few areas of the same character are found associated with the large areas of Susquehanna clay. These overflow lands are from one-eighth to 1½ miles in width, depending upon the size of the stream along which they are found. The large area in T. 16, R. 16, is not a stream bottom, but a low, level area with several drainage outlets.

Some of the areas of Yazoo clay are overflowed every season, while others are not overflowed oftener than every three to five years. The overflows generally occur in the winter and early spring months, but sometimes later in the season, inflicting serious damage to crops. Drainage is poor, except where ditches have been provided in the larger areas, or the streams cleared out and enlarged in the smaller areas.

This type is naturally heavily forested with oak of several varieties, hickory, sweet gum, and other deciduous trees. In many places there is a thick undergrowth of cane.

The Yazoo clay is a very valuable agricultural soil and nearly all of the small areas are under cultivation, as well as large tracts around the edges of the larger swamps. More of the type is being cleared every year. Cotton and corn are the principal crops. Cotton yields from one-half bale to 1¼ bales, and corn from 25 to 50 bushels per acre, without the use of fertilizers. As at least small areas of this soil are found on nearly every farm through the black prairie belt, they are more generally depended upon for corn, while the uplands are more largely used for cotton. Cotton usually fruits thinly and matures slowly, but the growth is so large that the yields are satisfactory. When well drained this is an excellent soil for forage and pasture grasses. Johnson and Bermuda grasses are becoming a serious hindrance in the cultivation of cotton and corn.

The average results of mechanical analyses of samples of fine earth of this soil are given in the following table:

Mechanical analyses of Yazoo clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12155, 12539	Soil	0.1	0.5	0.7	6.1	5.0	51.0	36.4
12156, 12540	Subsoil	.2	.6	.3	3.4	5.3	54.7	35.4

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12155, 0.74 per cent; No. 12156, 2.30 per cent; No. 12539, 13.58 per cent.

SUSQUEHANNA CLAY.

The Susquehanna clay is locally known as "red prairie," "post-oak prairie," or "beeswax lands." The second of the names has reference to the characteristic timber growth; the other two to the properties of the soil. The surface material, to a depth of 3 to 6 inches, varies in color and texture from a yellowish fine sandy loam to a very stiff red clay, and contains very little material coarser than fine sand. Either of the two extremes and intermediate variations may be expected in very small areas, but generally the slopes are the more sandy. The subsoil, to a depth of 3 or more feet, is a bright red or yellowish heavy clay, generally mottled with lighter colors. The tendency to mottle increases with depth, and below the third foot the color becomes more a gray. This clay is of a very plastic nature when wet, but becomes hard on drying, and at a certain moisture stage is very tough and sticky, making travel over it almost an impossibility. Some of the smaller areas are underlain by a white rotten limestone at a depth of 2 feet, and everywhere the type is underlain at varying greater depths by strata of this material. There are also occasional local outcrops of the limestone at the surface, giving rise to small areas of Houston clay. Around such areas are sometimes large numbers of shells, some of which are 6 inches in diameter. Lime concretions are almost entirely wanting, except in the smaller areas occurring in the black prairie.

Where newly cleared the soil usually is of a dark gray or brown color, but after a few years cultivation a large part of the humus disappears and the color assumes some of the lighter shades. As a whole the amount of organic matter present in the older developed areas is not sufficient to make the soil loamy or retentive of moisture. A greater part of the precipitation disappears in the surface drainage.

There is a phase of the Susquehanna clay that has practically the same topography and the same appearance as typical areas, but the clay appears to be more sandy and usually carries considerable mica. The surface is more generally sandy and the clay less sticky than with the typical soil.

The Susquehanna clay is the most extensive type of the area, being found in every township south of Montgomery. Small areas occur all through the black prairie belt in the northern half of the county, but the largest areas are farther south, where they form a broad belt across the county, interrupted only by the soils of small stream valleys. The detached areas in the southern part of the county are of the phase described above.

The principal tree growth consists of post, Spanish, and red oak and hickory, intermixed with shortleaf pine. The small areas in the southern part of the county are more heavily forested with shortleaf pine, and the second growth is nearly always of this species.

The surface features range from gently rolling to hilly and broken, but are rarely so rough that the soil can not be used for agricultural purposes. The higher ridges and knolls are divides between numerous small streams flowing through rather narrow depressions. The surface generally becomes more broken around the headwaters of the various creeks flowing north through the prairie region.

The Susquehanna clay is derived from sedimentary deposits of a transition period between the underlying Cretaceous limestones and clays of the next later formation, which gives rise to the soils of the Norfolk and Orangeburg series. It is thought that practically the whole prairie belt was once covered with sandy deposits, but if such was the case they have about all been removed by surface wash.

Something over half of the Susquehanna clay is under cultivation, but large tracts were abandoned during the civil war and many others since that time on account of a scarcity of labor. Cotton and corn are the principal crops. Cotton yields from one-half to 1 bale per acre and corn from 10 to 30 bushels. A limited acreage is in oats, which will yield from 20 to 30 bushels per acre. Some farmers use commercial fertilizers, but the practice has not yet become general, though gaining ground from year to year. In the line of forage crops and pasture grasses, Melilotus, Bermuda grass, and Johnson grass do well. The last two are looked upon with disfavor because of the difficulty of eradicating them, when once established, from the cotton fields, and none is used to any extent either for hay or pasturage. In many places alfalfa would prove a profitable crop. The Susquehanna clay offers good opportunities for dairy farming and stock raising.

The average results of mechanical analyses of typical samples of this soil are given in the following table:

Mechanical analyses of Susquehanna clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12153, 12537	Soil	0.2	0.5	0.4	4.5	16.5	38.3	39.5
12154, 12538	Subsoil	.0	.2	.2	2.5	5.4	35.4	56.0

CONGAREE LOAM.

The surface 4 to 8 inches of the Congaree loam is a brownish soil ranging in texture from a fine sandy loam to a medium heavy loam. The subsoil to a depth of 3 or more feet is a gray and brown mottled plastic clay carrying considerable fine sand. Here and there are small areas where the surface soil is deeper (12 to 15 inches) and the texture is lighter, being sometimes a fine sand and again a fine sandy loam. The soil in general contains an abundant supply of humus and can be farmed with excellent results any number of years without the use of commercial fertilizers.

The Congaree loam occupies the flood plains of the creeks and smaller streams flowing through the larger areas of the Susquehanna clay. Through the Houston clay belt it generally gives way to the Yazoo clay, which is a much heavier soil. A few small areas were also mapped along small streams in the extreme southern part of the county. These flood plains vary from one-eighth mile to 1 mile in width, and were originally heavily forested with oak, shortleaf pine, gum, magnolia, and hickory, besides a dense undergrowth of cane and bushes.

These lands are subject to occasional overflows, which generally occur in the winter and early spring. Some strips are subjected to floods every season, but a larger part of the type is not overflowed more than once in four or five years.

Large areas along Catoma, Pintlalla, and Pinchony creeks are still forested, but nearly all of the smaller swamps are cleared and being used for the production of cotton and corn. In favorable seasons cotton yields from one-half to 1 bale per acre and corn from 20 to 50 bushels per acre. The general practice is to farm this soil without the use of commercial fertilizers, the deposits from occasional overflows being sufficient to maintain its productiveness.

Where adequate drainage has been provided this is a very desirable soil and commands as high a price on the market as any other soil type in the county. The area under cultivation is being extended every year, and it is only a question of time when all of the type will be cleared and drained. It offers additional opportunities for diversified farming, which must come to this section sooner or later. It is a soil which, when properly drained, will grow a wide variety of crops suited to the climate.

The average results of mechanical analyses of representative samples of this soil are given in the following table:

Mechanical analyses of Congaree loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12418, 12558.......	Soil	0.7	5.8	7.8	54.6	12.2	11.3	7.5
12419, 12559.......	Subsoil.....	.1	.2	1.1	38.7	16.3	20.8	22.8

NORFOLK CLAY.

The soil proper of the Norfolk clay consists of 3 to 5 inches of a compact fine sandy loam or a silty loam ranging in color from gray to brown. In some places the sandy covering has been removed, giving a much heavier surface soil. The color varies directly with the amount of humus in the soil, which generally is not sufficient to keep it from baking and clodding under the plow. The subsoil to a depth of 3 or more feet is a yellow to yellowish-brown silty clay, which may be mottled to some extent with darker colors. The tendency to mottle increases with depth. The clay contains considerable mica and has a smooth feel in the fingers.

The Norfolk clay is of alluvial origin, occupying the larger part of the upper terraces of the Alabama and Tallapoosa river valleys. In elevation it is intermediate between the present overflow lands and the higher soils to the south.

The topography of this type of soil is level, except for occasional secondary terrace lines and old stream ways that are now in a semiswampy state or occupied by small streams. Drainage varies from fair on the higher lying ridges to very poor in some of the large level areas and in small depressions.

Something over half of the Norfolk clay is under cultivation. Cotton and corn are the principal crops, but a small acreage is used in the production of oats for home use. Cotton yields from one-half to 1 bale, corn from 10 to 30 bushels, and oats from 20 to 50 bushels per acre. Very little cotton is grown without the use of commercial fertilizers.

Better drainage and deeper plowing are the greatest needs of this soil. Large areas are now too wet to be used for agricultural purposes, while in many others the crops are rendered uncertain on account of wet seasons. The plowing being shallow and the soil too wet a part of the season, the crops are naturally shallow rooted. As a result they suffer unnecessarily from short periods of drought which occur nearly every season. More attention should be paid to a system of rotation that will keep the soil better supplied with humus.

The average results of mechanical analyses of typical samples of this soil are given in the following table:

Mechanical analyses of Norfolk clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12157, 12576	Soil	0.1	0.8	0.9	14.6	13.4	41.2	28.9
12158, 12577	Subsoil	.1	.3	.4	9.6	7.1	38.0	44.2

MEADOW.

The Meadow of Montgomery County includes wet areas that could not be otherwise classified on account of the mixed character of the soil materials. These areas occur along streams and are kept wet a greater part of the time by overflows and by seepage from the higher lands. In places the conditions were more nearly those of true swamp, but no attempt was made to show these separately. The Meadow is heavily forested with water-loving trees and shrubs, and with few exceptions no attempt has been made to bring it under cultivation.

If the streams were straightened and enlarged and a few ditches were provided for seepage waters, nearly all of the Meadow could be drained and made desirable soils, excellently adapted to the production of corn.

AGRICULTURAL METHODS.

The agricultural methods employed center around the production of cotton and corn and vary considerably among the farmers and in different parts of the county. In general there is a lack of thoroughness in preparing the soil for the reception of crops and in the after cultivation. Light one-horse plows are commonly used, and the plowing is necessarily shallow, the result being a seed bed only a few inches deep, and rarely in the best of tilth, resting on a subsoil, which instead of being broken up has been compacted at its contact with the soil by the repeated passage of the plow at the same depth. The exceptions to this are the result of inherent properties of the soil rather than of cultural methods. Except in the case of the types occupying the black prairie and the stream bottoms the humus in the soils has been reduced to a very small amount by planting continuously to cotton or corn over a long period of years. The result is that large areas have become nonproductive or give only small returns for the amount of labor expended. This condition is partially offset by the use of commercial fertilizers, but even then the results are often unsatisfactory and uncertain. It is a noticeable fact that all of the so-called worn-out lands in the county are very deficient in humus, and it is no less noticeable that the more thorough farmers do not have these worn-out lands. The tendency now is toward better methods, and the latest improved machinery is gradually being introduced and used to advantage.

On the Houston clay, Susquehanna clay, Yazoo clay, and Congaree loam commercial fertilizers are not used to any extent, but, except on the Congaree loam, the productiveness of which is maintained by overflow deposits, their use is being gradually extended from year to year, because the soils are becoming less productive under the present system of management. The methods employed here may be considered as peculiar to these types, hence they will be briefly discussed before taking up the other types of the county. Cotton and corn lands are generally prepared alike. If in these crops the previous year, the first thing is to run a large center furrow, then to bed the land over this with a one or two horse turning plow. Four furrows are required, two from each side. The soil is now ready for planting. Some do not consider it worth while to run the center furrows, hence their preparation consists solely in bedding the soil away from the old stalks with two or four furrows. If the soil is broken broadcast, it is then laid off and bedded as described above. A very large part of the preparation work is done in late winter and early spring, but some consider it a good practice to do most of this in late fall and early winter, so that the soil will be better subjected to aeration and the influences of winter frosts. Especially is this the case on the Houston clay and Yazoo clay, as these soils do not pack to any extent after rains, and slake into a soft mellow mass before planting time. Ordinarily this gives an excellent seed bed, whereas if plowed in the spring they are likely to be cloddy and harsh from having been plowed too wet. Fall plowing is also effectual in keeping in check insect pests, such as cutworms, grasshoppers, and the like.

The cotton is planted with a planter or by hand. It is a common practice to precede the planter with a bull tongue or small scooter plow. This is more generally practiced on the Houston clay and Yazoo clay, because they are so heavy and sticky. For corn a shovel furrow is run through the center of the bed, in which one to three grains are dropped in the hill at intervals of 18 inches to 3 feet. The covering is done by running a shovel furrow on one or both sides, or by a board used for covering cotton.

A great many of the negro tenants and some of the white farmers on the clay types mentioned above do not plant their cotton and corn in separate fields, but plant them together in one or the other of the following ways: One way is to plant the eleventh and twelfth rows in corn and the intervening ten rows in cotton. Another way is to cross over the cotton field at intervals of 15 to 30 feet, depending upon the strength of the soil. Hills of corn are planted where the rows intersect. As well as could be learned this system of farming was evolved as a result of occasional raids by "army worms," which have been known to entirely destroy the cotton crop. By planting corn in with the cotton at least a part of a crop is gathered, even if the cotton is destroyed. The system also serves the purpose of getting the negro tenants to raise their supply of corn. Usually they do not give the corn proper attention if planted separately. By having them together the cultivation is the same for both crops.

The methods of handling the Congaree clay and other loamy areas where fertilizers are not used are about the same as those practiced through the prairie.

On the other types of soil in the county the methods of planting and cultivating cotton and corn are essentially the same as practiced on like types all through the cotton belt, and are sufficiently well understood not to need extended discussion here. Mineral fertilizers are extensively used, either by themselves or in conjunction with stable manure and cotton seed. Nearly all of the fertilizers are applied in the furrow before the soil is bedded for planting. After the center furrow is run and the fertilizers distributed the next step is to ridge the land with two small shovel or turning plow furrows; then throw two more furrows over this with a one-horse turning plow. This puts the soil in shape for planting cotton. For corn no general system is followed. It may be planted in "water" furrows on the level or on beds, depending upon drainage conditions and individual ideas as to which will give the best results. Wet lands are more generally bedded.

The practice of "pulling" the fodder corn obtains throughout the county. In the prairie belt, where the cotton and corn are grown together, it is a common practice to bend over the cornstalks after the blades are pulled, so as to give the maturing cotton all possible sunlight. The corn is gathered in the late fall and generally housed without husking.

Johnson grass is the principal hay crop. In places through the prairie belt it has become a very troublesome weed in the cotton and corn fields, and it is so difficult to eradicate that wherever it gets a strong foothold it is allowed to occupy the land and is cut for hay. It is a perennial and all that is necessary in the line of cultivation is to plow the land once every two or three years. Some farmers have gone into growing this hay on an extensive scale and are making a good profit out of it. The hay is coarse, but it is nutritious and relished by stock. Bermuda grass is not used to any extent for hay, but it affords excellent pasturage for 8 to 10 months in the year. It begins growth in the early spring and is the last to die down in the fall. It, too, is troublesome in the cotton fields through the black prairie belt. The most effectual way of getting rid of it is to shade it out with a heavy growth of cowpeas. One season will usually do the work.

The "army worms" are occasionally very destructive on the Houston clay, Yazoo clay, and Congaree loam, and they may be expected to do some damage every season. Some farmers allow them to commit their ravages unmolested. Others keep them in check by poisoning the cotton with Paris green or London purple. The poison is generally applied in the dry state.

Very little specialized farming or crop rotation is being practiced. About the only rotation is the alternation of cotton and corn, and, more rarely, cotton, corn, and oats. Even these rotations are not systematically followed. The county with its great variety of soils offers almost unlimited opportunities for diversification, especially in the line of stock raising, dairying, forage crops, and fruit and truck growing; and until something more is done in this direction the possibilities of the soils will never be realized. As it now is, every effort is centered around cotton, the proceeds of which have to go toward buying things that could be produced at home more cheaply.

AGRICULTURAL CONDITIONS.

Since the civil war the white people have been drifting away from the farms to the towns and cities, because of the scarcity and unreliability of labor and in order to give their children better school and social opportunities. As a result, only a small part of the farming element is white, especially through the black prairie belt, where a large number of old slave plantation homes have been allowed to go to ruin. In the sandy sections both to the north and south of the prairie belt there is a greater proportion of white farmers, a large number of whom own and operate their farms. Some of these are successful, but a great many others are only able to maintain themselves from year to year.

The farm dwellings range from small, rudely constructed log cabins to large, modern residences, kept in good repair. The better houses are generally found on the Houston clay and the Orangeburg soils in the northern part of the county. Good outbuildings are the exception rather than the rule. In 1900, 193 negroes in the county owned farms. The remainder either rent lands or work for wages. As a rule they make only enough to keep them going, and give very little thought to the future. They almost invariably live in roughly built one or two room cabins, which in the timbered sections are generally built of logs and with a clay chimney.

In general there has been an increasing degree of confidence and prosperity among the farmers since cotton has been selling for good prices. However, the county still has the aspect of a section awaiting development.

The average sized farm contains about 64.5 acres, but as operated the greater number range from 20 to 30 acres—one-horse, tenant farms. A number of farmers own anywhere from 100 to 800 acres in one body. Parts of the larger of these are leased to tenants in small holdings. There are about two dozen farms of over 1,000 acres each. The tendency is to preserve these larger holdings intact except for temporary leases from year to year.

Of the 5,762 farms reported in the Census of 1900, only 667, or 11.6 per cent, were operated by the owners; 199 by part owners, and 45 by managers. Of the remainder, 4,332 were operated by cash tenants, 511 by share tenants, and 51 unknown. In renting the general plan is to rent a mule with so many acres of land, or so many acres to the mule if the tenant owns his stock. The area ranges anywhere between 20 and 40 acres to the mule, and the rent charged varies from $60 to $100. If rented by the acre, the price ranges from $2 to $5. As a rule there is very little uniformity in rates of rental.

Land values in the county are still comparatively low. The prices range from $3.50 to $5 an acre for the Norfolk sand to $20 to $60 for the better cleared and drained areas of the Congaree loam. The Susquehanna clay generally can be bought for $10 to $20 an acre, and the Houston clay and Yazoo clay and the Orangeburg fine sandy loam from $20 to $40 an acre. For the other types the same range of prices prevails, depending very largely upon the improvements, distance from town, and their recognized capacity for producing cotton. If in Illinois or adjoining States, such soils as the Houston clay, Congaree loam, and Orangeburg sandy loam could not be bought for less than $100 to $125 an acre.

Negroes furnish practically all the farm labor. Regular laborers are becoming more scarce every year by reason of so many leaving the farms for the cities and the desire of others to farm for themselves. This has led many farmers to lease their plantations and move to town. In places large tracts have been abandoned because of the scarcity of labor. The wages paid for regular hands are from $8 to $12 a month, with rations. They also are given houses and sometimes land to till. Day laborers receive on an average about 50 cents a day, except in cotton-picking times, when they are paid by the hundred pounds, usually from 40 to 50 cents.

Cotton is the all-important crop, and is grown by nearly every farmer throughout the county. Of the 261,974 acres of improved lands reported in the census of 1900, 133,660 acres were in cotton, yielding 39,202 bales of 500 pounds each. This is an average of about 1 bale to every 3½ acres. The yields on the sands are almost invariably light, but on the sandy loams, loams, and clays, with proper cultural methods and fertilization, the yields are anywhere from one-half to 1 bale or more per acre. There is great room for improvement in the methods used, especially among the tenants, who generally have little regard for the future conditions of the soil. While some cotton can be produced with scarcely any care, no crop responds more readily to good methods of tillage. By this is not only implied deep preparation and thorough after cultivation, but a system of rotation and manuring that will keep the soil in a highly productive state. A few of the better farmers know exactly what this means. By practicing more thorough methods the present output of cotton could be grown on half the acreage.

Corn, the next most important crop, is grown for home consumption, but a majority of the farmers do not raise nearly enough for this purpose. As a result they have to buy it at high prices or else partly starve their work stock—a poor policy always. The best corn lands are the Houston clay, Yazoo clay, Congaree loam, and the more loamy parts of the Susquehanna clay. The yields here range anywhere from 15 to 60 bushels an acre. The lighter sands are not good for corn, but at least parts of any of the other types can be made to grow good corn if properly handled. The great trouble is that the farmers will neglect their corn crop for cotton. In most instances they plant enough corn, but do not give it the proper attention. In 1900 the county produced 820,806 bushels of corn, an average of about 14 bushels per acre planted.

Many crops are grown in a limited way, among which may be mentioned oats, hay, sweet potatoes, miscellaneous vegetables, sugar cane, sorghum, and several others of less importance. Of the fruits pears, apples, peaches, and plums do well. There is need of more attention in the line of truck farming, dairying, stock raising, forage crops, including alfalfa, which is not yet grown to any extent, and fruit growing. There are soils in the county adapted to all of these products, the sandy types to fruits and vegetables and the clay types to forage crops and stock. The Houston clay, Yazoo clay, Susquehanna clay, and Congaree loam offer exceptionally good opportunities for growing forage and for dairying and stock raising. Stock can be kept on green grass nearly the year round.

As may be inferred from the above, the farmers in general pay very little attention to special adaptation of soils to crops. They know what types are best adapted to the crops now grown, but the tendency is to grow all the cotton possible, regardless of the type used.

Within the last ten years all of the public highways for a distance of 10 to 18 miles out of Montgomery have been graveled or macadamized at a heavy expense to the county. These are in excellent shape the year round and are being gradually extended. The ungraveled roads through the prairie are almost impassable throughout the winter months, but in dry seasons they become smooth and almost as hard as a pavement. The roads elsewhere are fairly good the greater part of the year. Poor roads have been a great drawback to the development of the county. The railroad facilities in the northern and western parts of the county are very good, but the extreme southeastern corner is anywhere from 12 to 18 miles from the nearest station. The roads passing through or terminating at Montgomery are through lines of the Louisville and Nashville Railroad and Western Railway of Alabama and terminals of the Atlantic Coast Line Railroad, Seaboard Air Line Railway, Central of Georgia Railway, and Mobile and Ohio Railroad. All of these afford through service to northern and eastern markets.

Montgomery is the central market for all of the products for sale. Some of the cotton is consumed by local mills, but the bulk of it is shipped to outside points.

SOIL SURVEY OF DALLAS COUNTY, ALABAMA.

By **E. P. CARR, W. EDWARD HEARN, HUGH H. BENNETT,** and **R. T. AVON BURKE.**

LOCATION AND BOUNDARIES OF THE AREA.

Dallas County is situated just to the west of the center of Alabama, lying between 32° 3′ and 32° 40′ north latitude and 86° 50′ and 87° 28′ west longitude.

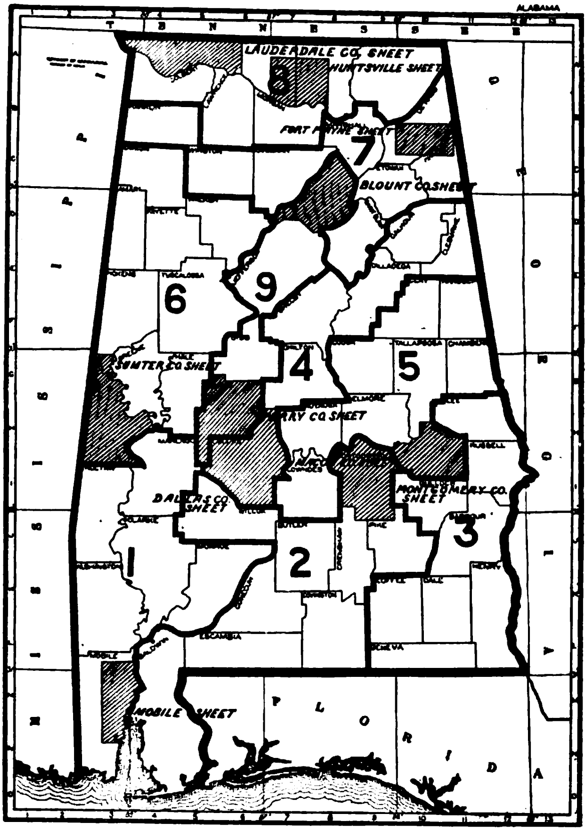

FIG. 18.—Sketch map showing location of the Dallas County area, Alabama.

The county is irregular in shape, and is bounded on the north by Perry and Chilton counties, on the east by Autauga and Lowndes counties, on the south by Wilcox County, and on the west by Wilcox Marengo, and Perry counties. Its area is 635,136 acres, or nearly 1,000 square miles. It is traversed in a northeast and southwest direction by the Alabama River. The city of Selma, the county seat and only city in the area, is at the head of the all-year navigation on the Alabama River, and is known in the State as the "Central City." The base map used in this survey was taken from a county map.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Dallas County was organized February 9, 1818, one year after the date when Alabama was organized as a Territory, and one year before the date when it was reorganized as a State. The territory for the county was taken from Montgomery County, and was named in honor of A. J. Dallas, of Pennsylvania.

Soon after 1818, when warfare with the Creek and Cherokee Indians had largely ceased, immigrants came from Virginia, the Carolinas, Georgia, and Tennessee, and the principal planters in the county to-day are largely descendants of this stock. In 1820 a majority of the 6,000 inhabitants were white, while in 1870 the population of 40,000 was about four-fifths colored. Of the present population (census of 1900) of 55,000, probably the same proportion are negroes.

Cotton has always been the chief, almost the exclusive, crop in this section. On the large plantations operated by slave labor some rice and tobacco were grown, with corn to feed the stock and hogs to make pork for the slaves, but cotton, the ready-money crop, was then, as now, the staple farm product, to the production of which all other operations were adjusted, and since in the cultivation of this staple the essential operation was the picking, the main consideration with the planters on their large estates was to plant as much cotton as the slaves could gather, and when these lands became exhausted to clear up new tracts.

While such a system of extensive farming did not prove, in the case of the less-exacting cotton crop, so ruinous to the lands as a somewhat similar system of extensive cropping in the bonanza wheat-farming of the northwest, it did, nevertheless, discourage any effort to maintain the fertility of the soil or to renovate old lands, and put a premium on land robbing. For the situation was here, as all through the South, more an economic question than an agricultural one. Lands were abundant, waiting to be cleared, and labor was plenty. There was no pressing necessity to consider intensive practices. With the increasing demand for land and the loss of slave labor the need of getting more out of the land and of making the hired labor more efficient has become important. The introduction of chemical fertilizers is also serving to emphasize the need of more systematic and intensive farming, for it has become pretty well established that it does not pay, as a business proposition, to buy fertilizers for lands that are poorly tended, and that to make the investment for fertilizers a profitable one, the soils must be kept in good tilth. In late years, also, the opening of northern markets to truck and fruit shipped from this section has encouraged diversified farming, and the recent introduction of improved cattle gives promise of considerable development in that industry.

The system of land tenure that has developed since the war is in many respects a drawback to the agriculture of the area, and is discussed in greater detail under "Agricultural conditions."

CLIMATE.

The following table, compiled from records of the Weather Bureau, shows that the Cretaceous prairie lands in the western part of Dallas County, represented by the data for Uniontown, in the adjoining county of Perry, have a somewhat higher temperature and a less precipitation than the sandier country around Selma. The figures given are normals computed from records covering a long period of years.

The date of the first killing frost in the fall is given by both stations as the second week in November; while the last killing frost in spring is recorded for Uniontown as the second week in March and for Selma as the last week in March. This gives a growing season of two hundred and thirty to two hundred and forty days, approximately.

Normal monthly and annual temperature and precipitation.

Month.	Selma.		Uniontown.	
	Temperature.	Precipitation.	Temperature.	Precipitation.
	°*F.*	*Inches.*	°*F.*	*Inches.*
January	40.0	4.58	47.1	4.75
February	47.8	6.28	48.2	6.44
March	58.1	7.37	56.3	5.35
April	63.6	4.44	65.8	3.95
May	72.3	2.65	73.5	4.00
June	78.9	4.23	80.1	4.45
July	81.4	4.67	81.7	5.47
August	80.6	5.65	80.8	4.75
September	76.0	2.04	76.6	2.50
October	66.4	2.15	67.0	2.01
November	54.8	3.22	56.0	3.10
December	47.3	4.44	50.3	3.88
Year	63.9	51.72	65.3	50.65

PHYSIOGRAPHY AND GEOLOGY.

The physiography of Dallas County comprises three distinct divisions—first, the hilly uplands in the northern and southern parts of the county; second, the sandy plains which border the Alabama River in its northeast and southwest course through the county; and, third, the rolling prairie or "canebrake lands" in the western part of the county.

The hilly upland area is composed of the Tuscaloosa and Eutaw formations across the northern edge of the county and of the Ripley formation in its southern portion, all of Cretaceous age. But these geological horizons, consisting of cross-bedded sands and clays, have been so overlain by the Lafayette mantle of later age that they exert little appreciable influence upon the derivation of the soils. The topography of this district is rough rolling to hilly, showing at times marked erosion, and rising to a maximum elevation of about 300 feet. The soils of this division comprise the Orangeburg fine sand, Orangeburg fine sandy loam, and Orangeburg clay, all derived from the Lafayette sands and clays. In the southern part of the county, especially, there is a well-defined series of gravel-capped hills, indicated on the map by the gravel symbol, which mark the more resistant crests of eroded sandy ridges. There are also found irregular outcroppings of the Selma chalk, giving rise to more or less isolated patches of heavy prairie clay within the sandier soils.

The second physiographic area consists of a sandy plain which borders, in a rough way, the tortuous course of the Alabama River, and which derives its character from the consequences of this river's agency. This alluvial flood plain of the Alabama River differs, however, from most southern river plains in having very little heavy bottom land subject to annual overflow. The reason for this is that the Alabama River has cut a decided gorge—or miniature canyon—30 or more feet deep into the underlying soft Cretaceous shale, with the result that in case of floods this gorge is glutted, while the banks are seldom, or in but few cases, flooded by the stream. Since the soils along the river are in general quite sandy and free from overflow, it seems evident that this alluvial area was not formed under present conditions, but represents an ancient deposition-plane at a time when the Alabama River was a wider stream or an estuary emptying into the nearby shallow waters of the Gulf and before the subsequent uplift in the land had induced the present canyon cutting in the stream. This view is supported by the occurrence of two sharply defined level plains, one east of Selma, the other between the river and Orrville, both now quite inland and wholly beyond the scope of river action, and which represent probable embayments in such a wide and shallow estuary. The smaller streams which empty into the river also show wide, sandy second bottoms, indicating a previous wider plane of deposition.

The geological age of these river or estuary deposits is quite recent (Pleistocene) and the topography of this area is noticeably level, becoming gently rolling as the uplands are approached. Several considerable bluffs, here and there along the river, show where ridges from the Lafayette uplands finger in at different points down to the course of the stream. The elevation at Selma is 147 feet, and this may be taken as fairly representative of this plain area. The characteristic soils of this division are the Norfolk series—Norfolk sand, Norfolk fine sand, and Norfolk fine sandy loam—showing coarser and finer grades of sediments. In certain areas constituting a lower river terrace, subject to occasional overflow, and especially near the mouths of the smaller streams which empty into the river and whose banks are overflowed in times of floods by backwater from the river, we find the Norfolk clay and the Ocklocknee clay, two heavier bottom soils.

The third physiographic division consists of the gently rolling prairie lands in the western and northwestern part of the county. These are known as the "canebrake lands," or the "black belt," and are derived from the weathering of the Selma chalk or Rotten limestone of Cretaceous age, which was laid down as an offshore deposit in deep water, and from which the Lafayette covering has been removed by erosion. This formation is exposed along the Alabama River and its tributaries and appears in large measure to underlie the entire county at a slight depth. It consists of thin beds of white limestone, from which Portland cement can be produced in select localities. Where it outcrops and weathers, especially in this western portion of the county, it gives the Houston clay—a heavy prairie soil.

Dallas County is well watered, the drainage of the smaller water courses being southeast or northwest into the Alabama River. The Cahaba River empties into the Alabama near the center of the county.

SOILS.

There are eleven types of soil in Dallas County. These are shown in color on the map accompanying this report. The table below gives the area of each type and the proportion which each forms of the total area surveyed:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Norfolk fine sandy loam	163,392	25.7	Meadow	11,584	1.8
Orangeburg fine sandy loam	159,040	25.0	Orangeburg clay	9,024	1.4
Houston clay	149,184	23.4	Swamp	8,192	1.3
Norfolk clay	61,312	9.7	Norfolk sand	7,168	1.2
Ocklocknee clay	29,056	4.8	Total	635,136	....
Norfolk fine sand	23,872	3.8			
Orangeburg fine sand	13,312	2.1			

ORANGEBURG FINE SANDY LOAM.

The Orangeburg fine sandy loam consists of a gray to dark-gray fine sand or fine sandy loam to a depth of 15 inches or less, overlying red sandy clay. This soil frequently contains small iron concretions, and at times bands of fine gravel. It is one of the widely distributed soils of the county, occurring as the main upland type in the northern and southern portions. In its topography it varies from rolling to quite hilly, and in places shows decided erosion. The drainage is good, and the soil frequently suffers from washing. Where this tendency to wash is developed with some uniformity over sufficient territory the soils grade into the Orangeburg clay.

The Orangeburg fine sandy loam is derived from the sands and clays of the Lafayette mantle, and is one of the characteristic soil products of that geological horizon. This Lafayette formation has been subjected to great erosion since its elevation above water, resulting in very unequal surface features for this soil type. Sandy ridges vary with gravel-capped hills, while in numerous directions the small brooks and creeks have developed their miniature valley systems often to a surprising degree.

The Orangeburg fine sandy loam is adapted to general farming, giving good yields of cotton and fair yields of corn and oats. It is especially well adapted to peaches, and in the adjoining county of Perry, together with the Orangeburg clay, is being used for the experimental production of a high grade of domestic Cuban filler tobacco.

Much of this type is still in forest, composed of a fair mixed growth of pine, hickory, black oak, and red oak, in which lumbering is occasionally conducted. The type, from its high position, is excellent for residence but offers difficulties to farming where the land is more rolling and subject to washing.

The gravel-capped hills and ridges, indicated on the map by gravel symbol, and found more prominently in the southern portion of the county, must be separated as the gravelly phase of this type. These areas are in general quite hilly in character and unsuited to general farming, but peaches are found to thrive on their well-drained hillsides. Such areas are as yet largely uncleared.

The yield of cotton on the Orangeburg fine sandy loam averages from one-half to three-fourths bale per acre.

The value of these lands ranges, according to location, proximity to railroads, etc., from $8 to $30 or more an acre. Many of these lands, however, can only be obtained by purchasing in large tracts, in which case a lower price can be secured. When leased, a yearly rental of $2 to $3 an acre is asked.

The following table gives the average results of mechanical analyses of samples of the Orangeburg fine sandy loam:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12700, 12702	Soil	1.3	12.2	12.1	36.7	16.1	14.5	6.3
12701, 12703	Subsoil	.3	5.8	7.6	25.2	12.5	18.4	29.3

ORANGEBURG FINE SAND.

The Orangeburg fine sand consists of a gray to brown fine sand to a depth of 15 inches or more, containing usually some iron concretions, underlain by red sandy clay. Irregular bands of gravel are sometimes found through the type. This soil is found here and there in the Lafayette uplands, wherever the surface soil of the Orangeburg fine sandy loam is developed to the requisite depth to pass into this type. The largest body is found in the northern part of the county, between Selma and Plantersville. Its topography is rolling to hilly; very similar to that of the Orangeburg fine sandy loam. The soil is well drained, and some areas show considerable erosion.

The Orangeburg fine sand is derived from the sands and clays of the Lafayette covering. It is especially adapted to peaches, is a good soil for truck crops, and is a somewhat earlier producing soil than the Orangeburg fine sandy loam, though not so uniformly productive.

Cotton yields from one-third to two-thirds bale per acre, and fair crops of corn are obtained. The area of the Orangeburg fine sand is inconsiderable in Dallas County, and with reference to local conditions the soil might be most aptly described as a sandy phase of the Orangeburg fine sandy loam.

The following table shows the average results of mechanical analyses of the Orangeburg fine sand:

Mechanical analyses of Orangeburg fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12696, 12694	Soil	0.0	3.1	19.4	53.5	7.2	8.5	7.9
12697, 12695	Subsoil	.0	1.8	12.5	45.8	4.3	6.0	28.2

ORANGEBURG CLAY.

The Orangeburg clay consists of a dark-red heavy sandy loam or light loam to a depth of not exceeding 4 inches, overlying a red sandy clay subsoil. On cultivated areas the transition between the soil and subsoil is more gradual both in texture and in depth, due to the effects of plowing and high bedding.

The Orangeburg clay occurs in the higher parts of the uplands, the main bodies of the soil lying in the neighborhood of Summerfield and north of Richmond. Its topography is at times very hilly, but there are frequently to be found high but fairly level areas which make very good farming lands. The occurrence of such level tracts at the most elevated position of the uplands indicates that the present crests of the hills and ridges were once the plane of an extensive and uniformly level peneplain, and that these hilltops and ridges are the results of excessive erosion upon such a peneplain, and by no means due to any process of violent uplift. The soil is well drained, and in the hillier areas must be protected from washing.

The Orangeburg clay owes its origin to marked erosion of the Lafayette sands and clays in the uplands, and is developed where the sandy surface soil is measurably removed from such soils as the Orangeburg fine sand and Orangeburg fine sandy loam.

The Orangeburg clay is the best adapted to general farming of any of the Orangeburg soils. Cotton yields from one-third to 1 bale per acre and corn from 15 to 35 bushels. Oats do well also, but wheat is rarely planted in Dallas County, owing to its liability to rust. It is probable that this tendency to rust could be somewhat overcome by taking special pains to plant the wheat very early in the fall (August or September) and so hastening an early maturity in the spring. But at this time of the year the cotton crop generally engrosses all attention, and, moreover, the season is liable to be dry for planting.

The tracts of Orangeburg clay are pretty well cleared up in this county, the native growth being mostly hardwoods. It is said, however, that while crops produce more on this soil in good seasons than on the sandier types, they are liable to suffer from drought even more than on the sandy soils. This type has, however, naturally a higher moisture capacity than these sandier soils, and its liability to drought must be traced to the fact that it is plowed too shallow. This shallow plowing is not so prejudicial on the sandy soils because there is always a considerable sandy root zone before the clay subsoil is reached. But on this clay soil, unless plowed deep, the crops are unable to develop a sufficiently deep root system in the unbroken clay, and the surface roots suffer as soon as the shallow-tilled surface dries out.

The value of the Orangeburg clay is probably somewhat higher than the value of the Orangeburg fine sandy loam, running from $8 to $40 an acre. In Perry County both these types are being used for the experimental growing of a Cuban seed filler leaf tobacco, and if successful this will give these soils added value.

The average results of mechanical analyses of samples of the Orangeburg clay are given in the following table:

Mechanical analyses of Orangeburg clay.

Number.	Description	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12706, 12704	Soil	0.0	1.4	6.3	38.7	4.3	19.1	29.7
12707, 12705	Subsoil	Trace.	1.1	5.2	29.5	3.7	16.5	43.7

NORFOLK FINE SANDY LOAM.

The Norfolk fine sandy loam is a gray fine sandy loam, underlain at a depth of about 20 inches by a yellow sandy clay. This type is the most widely distributed soil in the area, and is found, some distance back, along the main water courses. The two largest bodies approach the Alabama River from each side, east and west, about the center of the county.

Like the other Norfolk types, the Norfolk fine sandy loam is mainly a river-plain type in this area, the topography varying from large level areas of low plains to gently rolling hills as the uplands are approached. The soil is generally well drained, except in certain depressed areas in the level plain between Cahaba and Orrville, which do not dry out adequately until late in spring, and which would be readily improved by a drainage system. This type owes its origin to former estuary depositions, and in the more rolling areas to the sands and clays of the Lafayette formation.

The Norfolk fine sandy loam is well adapted to late truck crops and to cotton. In this area it is largely devoted to the production of cotton, although some truck is grown upon it also. It is also used to grow corn, giving moderate yields. The lower lying areas of the type are better adapted to corn than the more rolling portions.

It is advisable, in this county, to recognize as a special phase of the Norfolk fine sandy loam the lower lying plain areas similar to the depressed areas between Cahaba and Orrville, above referred to. These tracts have in general a somewhat shallower surface soil than the main portions of the type, with doubtless a higher proportion of very fine sand and silt, and they are, as a rule, so moist that they would be greatly benefited by artificial drainage. It would seem that these lower lying and shallow-surfaced areas would be well adapted to growing strawberries, as this crop, on account of its short root system, is liable to suffer from drought or be "burned out" if grown on the sandier phases of this type. Cabbages would also doubtless be more at home on this moister phase. The sandier phases of the main type, however, constitute a better all-round truck soil.

Cotton yields on an average from one-third to one-half bale, while corn seldom produces over 10 bushels per acre.

A good proportion of this soil is cleared and under cultivation. The native forest growth consists largely of pine and live oak, and some lumbering is still conducted in the lower lying areas, which are more subject to malaria and occupied mostly by negro tenants. Its value is about the same as that of the Orangeburg fine sandy loam.

The mechanical analyses of samples of the Norfolk fine sandy loam are shown in the following table:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12690, 12688	Soil	Trace.	1.7	6.4	52.6	15.4	16.6	6.9
12689, 12691	Subsoil	0.3	3.1	6.7	33.2	17.6	18.4	25.0

The following sample contains more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12689, 0.88 per cent.

NORFOLK FINE SAND.

The Norfolk fine sand is a fine, gray, loamy sand, 8 to 10 inches deep, underlain by a yellow fine sand, slightly more loamy and adhesive. The soil is quite friable when dry, but has a tendency to pack or form a surface crust after being wet. It is mainly found along the courses of the Alabama and Cahaba rivers, with occasional areas in the uplands. The topography varies from a series of level plains to more rolling hillside areas in the uplands. The drainage is good, but the soil is not leachy like the Norfolk sand.

The Norfolk fine sand has been formed in two ways. Along the river courses it represents the finer sand deposits, while in the uplands it represents areas where the fine sand materials of the Orangeburg fine sand and Orangeburg fine sandy loam have accumulated to such depth as to necessitate a change in the classification. The sand accumulation, it was noted, is generally due either to the washing out of fine sand and its accumulation at the base of the hillsides, or to accumulation by soil creep, sometimes seen just at the break of the hillsides.

This soil, like the Norfolk sand, is best adapted to early truck, small fruits, and peaches, and is too light for general farming purposes. The yield of corn is scanty. Cotton is the crop generally planted on this soil, but the yields are so dependent upon the use of chemical fertilizer that they are but little indicative of the strength of the soil. Perhaps one-third bale of cotton per acre is the average yield. This type is nearly all under cultivation, which indicates that it is a better cotton soil than Norfolk sand, on which the cultivation of this crop is the exception.

The following table shows the results of mechanical analyses of the Norfolk fine sand:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12686, 12684	Soil	0.1	5.0	25.0	41.3	6.1	12.7	9.8
12685, 12687	Subsoil	Trace.	3.8	22.1	39.9	6.5	16.4	10.9

NORFOLK SAND.

The Norfolk sand is a coarse to medium gray sand, very loose and incoherent, resting on a yellow sand of the same texture, extending to a depth of 3 feet or more. It occurs as small, irregular areas scattered here and there throughout the course of the Alabama River plain. Its topography assumes the form of loose sand knolls, attaining at points the character of dunes, devoid of sod or other plant covering. On account of its coarse texture and somewhat elevated position the soil drains readily and crops suffer from drought. The patches of this soil generally occur close to the river front, and represent the coarser sediments of earlier river action.

The Norfolk sand makes a poor soil for general farms crops, but is well adapted to early truck, except such vegetables as cabbage, which require a heavier subsoil. Small fruits and peaches also do well, especially if grown for an early market. The soil is in general adapted for those crops in which quick maturity without interruption of growth and tender quality of leaf are more sought for than quantity of yield.

The native vegetation of the Norfolk sand in this area is merely a scrub growth of live oak and wild cactus. Where cultivated it is used for cotton, but gives a very light yield even in favorable seasons. Some small patches were seen planted in corn, but corn is not to be recommended.

It is well to mention a stronger phase of the Norfolk sand which was found in the area. This phase has a more level position, the surface soil contains more organic matter, and the subsoil is somewhat sticky and shows a decided red color. This is simply a heavier phase of Norfolk sand, and though likewise liable to suffer from drought, it produces fairly good yields of cotton in average seasons.

There is also an occasional spot of Norfolk sand to be found in the uplands, where the finer materials have been washed out of the Orangeburg fine sand and the subsoil of coarse sand made deeper.

The following table shows the average results of mechanical analyses of samples of the Norfolk sand:

Mechanical analyses of Norfolk sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12678, 12680	Soil	0.3	26.4	45.2	18.2	1.3	2.2	5.8
12679, 12681	Subsoil	.1	22.3	47.6	22.1	1.2	1.9	4.6

HOUSTON CLAY.

The Houston clay, known as the prairie "canebrake lands" and as the "black belt," consists of a gray, brown, or black loamy clay, with a depth of 6 inches, overlying a very heavy gray or mottled yellow clay to a depth of 3 or more feet. This material is underlain at varying but shallow depths by the typical Rotten limestone, or Selma chalk. Lime concretions are found throughout the profile, especially in the subsoil.

This soil occurs in the western part of the county as a large compact area, extending from the Cahaba River north and west into Perry County. Other considerable areas are also found north of Selma and in the southern part of the county, as well as in scattered irregular outcroppings. Its topography is that of a gently rolling prairie, and the drainage is very good. In some areas the soil is subject to washing.

The Houston clay is derived from the weathering of the Selma chalk or Rotten limestone of Cretaceous age, and is the only soil in the area in which atmospheric weathering and the solvent action of rain water have played a decided part in the derivation of the type. Portions of this soil are colored red, yellow, and brown, indicating varying contents of iron. As a result of its high lime content, the soil shows very decided flocculation of its clay materials, a feature of much agricultural importance on such a heavy type. The lime concretions contain sometimes a small proportion of phosphate, so that this soil is to this extent self-fertilized.

It is needful to recognize two special phases of the Houston clay apart from the main type just described. The first of these is the "lime-hill" phase, in which the underlying shaly limestone is close to the surface, with the result that the surface soil is thin and washes badly, showing frequent gall spots. The occurrence of this phase, however, is too irregular to be indicated on the map. Farm crops grown on this phase are subject to drought, and the best purpose to which such tracts can be put is the growing of forage crops that do not require clean cultivation, with its attending inducement to washing, and serve to bind the soil and to accumulate a deeper soil cover.

The second special phase of Houston clay consists of those marginal areas of the type, where this soil begins to grade into the neighboring sandy types and is slightly modified by their materials. This phase has practically the same texture as the main type, but is covered with a very thin veneer of sand on its surface, and occasionally contains some fine gravel. Such areas represent locations in which the Lafayette covering has not been so completely removed as in the main type, but this slight modification is lost sight of when these lands are plowed, or exert, if any, a slightly beneficial action upon its texture. These tracts, sometimes known as "red post-oak prairie," are frequently of a yellow to red color, which seems to indicate that that they have been iron stained, in part at least, from the but recently removed Lafayette cover, which is uniformly rich in iron concretions.

The Houston clay, while clodding badly when plowed too wet, and requiring care in its management, is a very strong and productive soil, and is especially adapted to forage crops and live-stock raising. It is the chosen home of the Johnson grass and of the Melilotus clover, while alfalfa does surprisingly well for such a heavy soil. The cattle industry is being developed on these lands in the county, and gives good promise of success. Cotton produces from three-fourths bale to over a bale per acre, although in some cases it is said that the rich soil encourages excessive growth of stalk at the expense of the set of bolls. On such exceptionally rich tracts corn is the safer crop for the first seasons. The yield of corn runs from 20 to 50 bushels per acre. The growth of fig trees on this soil was noted to be very fine.

The Houston clay supports in general only a meager and scattered forest growth. It is fairly well watered with streams, but surface wells are impracticable on account of the shallow depth to bed rock and the lack of seepage in the dense subsoil. Water is generally obtained in abundance from artesian borings, but cisterns are largely used for the household supply.

The value of the Houston clay lands is from $12 to $50 per acre, and a yearly rental of $3 to $4 per acre is generally obtained when the land is leased.

The average results of mechanical analyses of samples of the Houston clay are given in the following table:

Mechanical analyses of Houston clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12672, 12676.......	Soil........	0.6	2.1	2.5	13.5	8.9	25.8	46.7
12673, 12677.......	Subsoil....	.2	.9	1.0	6.4	2.1	15.4	72.1

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12672, 35.94 per cent; No. 12673, 7.72 per cent; No. 12676, 24.20 per cent; No. 12677, 51.91 per cent.

NORFOLK CLAY.

The Norfolk clay consists of from 2 to 5 inches of heavy fine sandy loam, or loam underlain by a stiff, mottled, reddish and yellow clay. It occurs prominently along the courses of the Alabama and Cahaba rivers, occupying the lower areas in their river plains and being subject in some places to occasional overflow. Its topography is flat and low lying, the soil occupying an intermediate position, in location as well as in texture, between the terrace phases of Norfolk fine sandy loam and the heavy river bottom areas of Ocklocknee clay. The drainage is generally poor and in need of artificial improvement.

The Norfolk clay type owes its origin to the deposition of finer sediments, and is found most characteristically on the concave side of the river bends.

A little surface ditching is generally sufficient to insure adequate drainage, when the Norfolk clay becomes a productive soil. On account of its position it is able to withstand considerable drought. The soil is well adapted to general farm crops, yielding three-fourths to one bale of cotton and 20 to 40 bushels of corn per acre. It is also capable of yielding good crops of hay, but has been used for this purpose but very little in Dallas County.

The Norfolk clay soil is very liable to clod if plowed wet, and, because the type is somewhat late in drying out in the spring, it generally is plowed in too wet a condition. Proper drainage is the only way to make the soil dry enough for early plowing, unless cover crops are planted in the fall and cut in early spring after their renewed growth has taken up some of the excessive moisture.

The Norfolk clay is known locally as "sandy hammock land," or as "isinglass land," although these terms are applied with little consistency.

These lands are largely leased to negro tenants at an average annual rental of $2 an acre.

The following table shows the average results of mechanical analyses of samples of Norfolk clay:

Mechanical analyses of Norfolk clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12710, 12708	Soil	0.1	1.3	3.3	21.4	17.7	34.5	21.3
12711, 12709	Subsoil	Tr.	.3	1.5	20.8	11.2	24.2	41.3

OCKLOCKNEE CLAY.

The Ocklocknee clay is a dark-gray silt to clay loam, with a depth not exceeding 6 inches, overlying a very heavy dark-brown clay. It occurs in small areas along the Alabama and Cahaba rivers, as the lowest river terrace subject to overflow, but its main area is found in the heavy bottom lands along the smaller tributaries of the Alabama River, like Boguechitto, Morgan, and Cholatchee creeks. Its drainage is very poor, and for systematic cropping the soil would require both draining and diking. This type is due to the deposition of silt and clay sediments laid down chiefly in times of floods, when backwater from the Alabama River causes the smaller tributaries to overflow their banks. The texture of this soil shows some variation, according as it is modified by wash from the sandy hillsides or grades into the Houston clay as the prairie is reached.

This soil is difficult to till, and clods badly unless plowed when dry. It is known locally as "black swamp" land, and on account of its rather unhealthy location is occupied almost exclusively by negro tenants. When properly plowed and cultivated it is a strong soil, yielding 20 to 50 bushels of corn and a bale of cotton per acre. Like the Orangeburg clay in this respect, the Ocklocknee clay is said to suffer from drought, and cotton is reputed to rust in dry seasons, no doubt for the reason that the stubborn clay is plowed so shallow. On such a heavy soil, plowed shallow and without the mellowing effects of any incorporated organic matter, cotton, and especially corn, may well suffer in dry seasons from the inability of the tenacious soil to deliver its water supply as fast as required.

The Ocklocknee clay is well adapted to grow hay and for pastures, but is not used for these purposes to any extent, except in some limited areas which have a growth of wild cane.

The table following shows the average results of mechanical analyses of the Ocklocknee clay.

Mechanical analyses of Ocklocknee clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12670, 12668	Soil	0.2	1.0	1.9	15.3	11.0	37.7	36.6
12669, 12671	Subsoil	Tr.	.6	1.3	15.6	9.6	35.5	37.0

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12668, 3.41 per cent; No. 12669, 0.92 per cent.

MEADOW.

The Meadow consists of low-lying and poorly drained tracts near the head of some of the small tributaries of the Alabama, and too wet for systematic cropping. The soil is a heterogeneous mixture of sand and silt, being the sandy wash from the hills mingled with over flow deposits. In winter these lands are quite wet, but in midsummer they frequently dry out so as to yield good pasturage, and some of the grass is cut for hay. In a season of protracted drought they may make good corn yields.

Some of the Meadow can be readily drained, and would then afford good lands for corn and grass, especially for such a grass as redtop, which requires a moist location in this climate.

Sugar cane is said to do its best on the strips of moist sandy "branch land," similar to Meadow, better than on the heavier bottom soils (Norfolk clay and Ocklocknee clay). The yield is smaller than on the stronger soils, but the sugar content is higher and the flavor more delicate. The sandier bottoms induce a quicker growth and a finer texture in the plant. As a result the main energies of the plant are consumed in elaborating sugar for the immediate food requirements of the rapidly maturing cane, and less of its energy is diverted, at the expense of its sugar content, to storing up starch as a reserve food for a prolonged and excessive growth, such as clay soils give.

SWAMP.

The Swamp type of soil has no agricultural value, and consists of depressed areas along the smaller tributaries of the Alabama River, covered most of the year with standing water and occupied by a heavy growth of cypress and other water-loving trees. The more prominent areas of Swamp are Langs Pond, on Morgan Creek, and Blue Girth Swamp, on Beech Creek. There is no Swamp along the immediate course of the Alabama or Cahaba rivers. It is doubtful if any of this area could be profitably reclaimed.

AGRICULTURAL METHODS.

The agricultural methods of the area are very largely a matter of convention, and not as well adapted to the different types of soil as their variation in character seems to make advisable. We do, indeed, find on the heavy prairie lands a style of plow with a more oblique plowshare than that in the plow used on the sandier soils. The constant growing of cotton and corn, on the other hand, has tended to establish a too uniform method of cultivation on the different soil types.

Fall plowing is seldom practiced, although it would doubtless be beneficial on the heavy prairie lands. The disintegrating action of frost would serve to break down the compact clay and make the soil mellower, besides making plant food available by weathering. On the other hand, fall plowing may be injurious to sandy soils unless they are subsoiled, as it may otherwise cause them to wash and to pack or cement together badly after the winter rains.

It would seem that deeper plowing can be safely and profitably practiced on all the soils if properly conducted, for on very many of the soils of the area, and especially on the sandier types, there is found a well-developed hardpan or layer of hard and closely compacted sand, 2 or 3 inches below the surface, due to turning these soils when too wet and afterwards plowing at the same shallow depth for years. This hardpan causes the soils to shed the winter rains instead of absorbing them, and thus encourages washing. For the same reason the crops suffer in dry seasons, because the development of a root system is hindered and the capillary water supply is obstructed. The remedy for this hardpan is in plowing, which must be gradually deepened for a number of years. Some farmers claim that deep plowing "kills" these sandy lands, and this opinion may be well founded if this inert and unweathered hardpan is turned up on top of the mellow top soil all at once. If, however, this turn plowing is done gradually, going just a little deeper each year, a seed bed of good depth could soon be established without such harmful results. Subsoiling, however, is the readiest remedy for this hardpan, and is to be highly recommended on these shallow plowed beds. In this way the hard layers are broken down and mellowed without being turned on top, and the soils are benefited in several ways. On the heavy prairie soil deep turn plowing is said to be a safe practice, just as is fall plowing on this soil, but on the sands and sandy loams subsoiling is the surest operation.

Little attention is given to the rotation of crops, as land is plentiful and commercial fertilizers are largely relied upon to keep up crop yields. The common practice is to follow cotton with corn in case any rotation at all is attempted, or to intersperse corn in the cotton rows year after year without rotation of any sort. Since both these crops require clean cultivation, they rapidly exhaust the humus in the soil. Where manure is not used the only way to replenish the humus is to introduce some crop into the rotation which will leave a stubble or sod to be plowed under. Oats will suggest itself as the most usual crop with a stubble that is planted in this county, and it would be well to grow this crop in a rotation with corn and cotton. But it is the leguminous crops—cowpeas, crimson clover, or the familiar lespedeza—that are to be especially recommended, both because they can be turned under to add humus and because of their specific benefit in enriching the soil with nitrogen. One of these legumes should be a factor in any rational scheme of rotation.

Cotton-seed meal and acid phosphate are the two fertilizing materials most largely used in the Dallas County area, and there seems to be a disposition to leave out the potash salts, probably because the other fertilizers are southern products and more readily obtainable. Some of the sandy upland soils, as well as some of the heavy bottom types, show by the character of their growth that applications of lime would be very beneficial.

There are found, at several localities in Dallas County, noticeably at the contact of the Lafayette and Cretaceous limestone formations, seams of phosphate rock and greensand, which show an analysis of 2 to 5 per cent of phosphate of lime. Some of these materials are worthy of trial, where they can be ground up, as phosphatic fertilizers. A very efficient homemade superphosphate is known to have been made from this source by the use of sulphuric acid.

There are also to be found, scattered through the Selma chalk, small beds of large shells which yield, on burning, a good quality of lime.

AGRICULTURAL CONDITIONS.

The prosperity of the farming class in different parts of Dallas County is quite divergent, as is to be expected in an area which shows such marked contrasts in its social and economic conditions. Since only about 11 per cent of the farms are operated by their owners the small independent farmer is not the characteristic type of agriculturist, but the farming class is quite sharply divided into the white landholder and the negro tenant. The prosperity of the landholder, who is frequently likewise a merchant, is, in general, very good, many of them being owners of large tracts of land and in affluent circumstances. Their homes are commodious and well appointed and in striking contrast to the rude cabins of the negro quarters. On account of the mild climate the barn is an undeveloped affair, and takes the form of a more or less open shed. Fences are in general unnecessary, except where improved cattle must be kept isolated from the common scrub stock, and in such cases the rail fence is the usual type.

The tenant system in common vogue is an outgrowth of the conditions following the abolition of slavery. The predominating negro tenant is classed either as a "halves tenant" or as a renter. In the first case the tenant or tenants—for the negroes sometimes prefer to lease land together in a small squad—are furnished the land and mules and get half the crop. The renters are those negroes who own their own teams, and they pay a rental of $2 to $3 an acre for the sandy lands and from $3 to $4 for prairie tracts, or they may pay from $40 to $60 for a "mule's land" and work as much as they can with one team. In all cases the landowner furnishes them houses (cabins). These tenants and renters are not furnished rations, but a characteristic system of "advancing" is practiced to insure them food during the crop season. From about the 1st of March until August the landholder—and for this reason generally a merchant, too—advances rations, such advances being charged against the crop. He also in a measure oversees the production of the crop.

Other negroes are employed by the landowners for their own service. These "contract hands," or "wages squad," get from $8 to $10 a month, are furnished rations, and in some cases are allowed the use of 3 acres of land and given a mule to work it on Saturdays.

While this tenant system no doubt has its economic justification in the conditions it has to meet, it does nevertheless embody some serious disadvantages to the agricultural progress of the area. First and foremost, it tends to place the conduct of farming operations out of the hands of the landowners and to intrust it to the tenants, who, as a matter of course, give little or no thought to the welfare of the land. The consequence is that the landholder is brought into competition with a lower class of producers, whom he himself serves to support, the price of cotton is forced down, and skilled farming is put at a discount. The tenant, on his side, is obliged to pay a high interest on the advances made him to protect the merchant against loss on such risks, and has little chance to better his condition. It would seem that with a larger class of owners conducting farm operations themselves, and a consequent increase in the number of wage hands, the condition of both classes would be probably bettered and the chance given to control the cotton acreage by diversifying crops. The price of the staple would not then be so subject to decline from thoughtless overproduction.

The average size of the farms in the area is 64 acres, but many of these are parcels of large tracts of land embracing several thousand acres under one ownership.

The labor is entirely that of the negro class, and is quite efficient when properly supervised. Some of the lower lying portions of the area are unsuited to white labor on account of malaria.

Some improved farm machinery is to be found, but on account of the abundance of labor this does not become such a vital question in this section. In fact, some of the most intelligent farmers deliberately withhold the use of improved machinery from their hands in order to provide them more constant employment, and for the reason especially that so many hands must be kept together to tend and pick the cotton crop.

Cotton is, as stated, the chief product of the county, occupying about one-third of its entire acreage and giving a production of over 48,000 bales. This places Dallas County among the largest cotton-producing counties in the State. Corn ranks second, with an average yield for the county of 14 bushels per acre. Oats and sweet potatoes follow in order, but with a greatly reduced acreage. The production of hay is not known, but a good quality of Johnson grass hay is produced on some of the prairie lands and this industry has bright prospects. The trucking interests are just beginning to be developed, and radishes, peas, Irish potatoes, tomatoes, and strawberries are grown on the lighter sandy soils for early shipment to northern and western markets. The peach industry is also making progress on the Orangeburg fine sandy loam uplands, the chief varieties grown being the Elberta and Slappey varieties.

The raising of beef cattle is one of the newer agricultural industries which is gaining ground in this area, especially on the Houston clay type of soil. Improved herds of Hereford, Shorthorn, and Red Polled cattle have been introduced and give promise of marked success where the grazing season is so long, where the Johnson grass does so well, and where Bermuda grass and Melilotus clover furnish desirable pasturage. As this section lies below the quarantine line, cattle brought in from northern localities must be inoculated against tick fever.

The acreage in sugar cane is larger than that in sorghum, and its growth is at present receiving renewed attention. As already stated, the sandier second bottom lands are found to produce a stalk of higher sugar content than the heavier clay bottoms, and on the same principle the upland cane on the Norfolk fine sandy loam and the Orangeburg fine sandy loam is claimed to have a still higher sugar content, but with a likewise lower yield than the sandy "branch lands." It is largely a question of business profits—that is to say, of special markets—how far this sacrifice of yield to quality can be successfully carried in preferring the sandy uplands for the growth of this product.

The sandy bottom lands are preferable also for the production of pecans, some orchards of which have been lately planted.

Such cases as those just cited indicate that there is a fair recognition of the adaptation of special crops to special soils in this area. It is, however, in the more general farm crops, and especially in what might be termed the tyranny of the cotton staple, that the question of adaptation of crop to soil is largely overlooked and a conventional routine of culture on different soils and in differing seasons too blindly adhered to. The soils in Dallas County are as widely different in character as is well possible, and in an area which possesses so many varying types and which is by nature so well suited to an intelligent diversification of crops, the need of more specific consideration of the soil in its relation to the required crop or quality of crop is to be emphasized.

The transportation facilities of the county are exceptionally good. The Southern Railroad has branches to Mobile, Meridian, Birmingham, and Rome, Ga., which intersect the county, while the Louisville and Nashville Railroad has branches from Selma to Pensacola and to Myrtlewood, and the Western Railway of Alabama has a line from Selma to Montgomery. Thus at least seven distinct railway lines traverse the county in nearly all directions, while the Alabama River, with boats to Mobile and Montgomery, is a channel for steamboat transportation through the heart of the county.

The county roads are in general unimproved, and travel with teams is somewhat discouraging. The prairie roads are excellent in summer, but become impassable and utterly unfit for travel in winter. The sandier sections offer better roadways, but in summer become very dry and sandy.

The only local market in the area for cotton is Selma, the county seat, where in the neighborhood of 100,000 bales of cotton are handled from this and adjoining counties. Some cotton is also taken to Uniontown, in Perry County, but Selma is the general market for the staple farm crops and the chief center for wholesale distribution in the county. The northern and central cities, as far as Pittsburg, Cleveland, and St. Louis, offer markets for early truck and peaches.

SOIL SURVEY OF THE CRYSTALSPRINGS AREA, MISSISSIPPI.

By **JAMES L. BURGESS** and **W. E. THARP.**

LOCATION AND BOUNDARIES OF THE AREA.

The Crystalsprings area is located in the northeast part of Copiah County and the northwest part of Simpson County, Miss. The greater portion of the area lies in Copiah County, and includes most of the famous Crystalsprings trucking district.

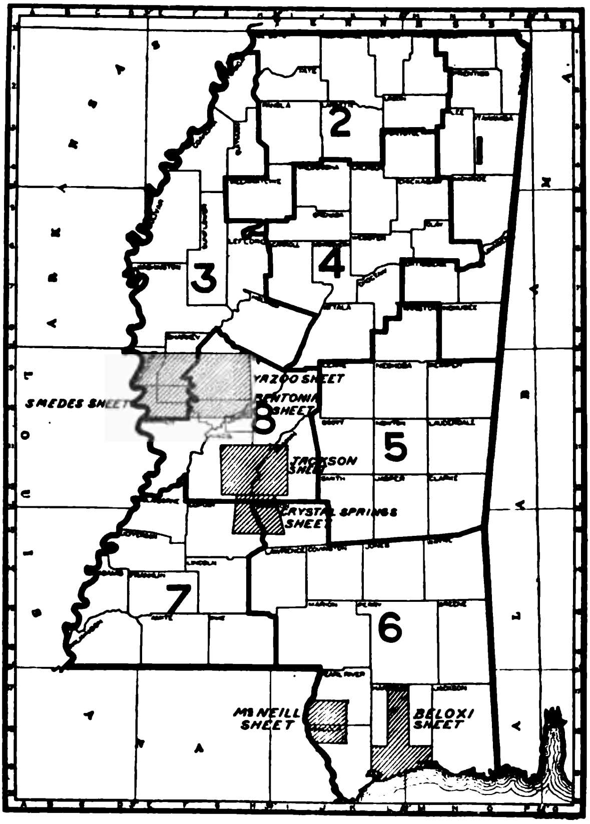

FIG. 19.—Sketch map showing location of the Crystalsprings area, Mississippi.

The area is about 150 miles north of New Orleans, and approximately 770 miles south of Chicago. It is traversed from north to south by the Illinois Central Railroad, and is served by Crystalsprings, Gallman, and Hazlehurst as shipping points.

The area contains 147,840 acres, or 231 square miles, and is bounded on the north by the Jackson area, surveyed in 1904.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Prior to 1819 the territory of the present counties of Copiah and Simpson was claimed by the Choctaw Indians. During that year the Indian claim was extinguished, and four years later (1823) Copiah County was organized with boundaries that included Simpson County and a part of Lincoln. In 1824 Simpson County was organized, with Pearl River as the boundary between it and Copiah. When Lincoln County was formed, in 1870, a narrow strip of territory on the south side of Copiah was included in the new county, thus leaving Copiah County with its present boundaries. Gallatin was the first county seat of Copiah County.

With few exceptions, the white population of the Crystalsprings area is strictly southern, and has had a southern ancestry for generations back, the original settlers having immigrated from Virginia, North Carolina, Maryland, South Carolina, Georgia, Kentucky, Tennessee, and other Southern States.

The earliest settlers came to this part of the State between 1810 and 1820. Land was cheap, and soon large tracts became the property of men who had nothing on their arrival. The land was largely forested, and much valuable timber was destroyed in the development of new homes. It was the custom, and is yet in some places, to open up new fields, "wear them out," and clear up others. Thus the early agriculturist, without any attempt to perpetuate the fertility of his soil, gradually moved over his wide acres, cultivating only the new and best land and allowing the older, worn-out fields to wash away or grow up in pines. To-day thousands of acres of barren, gullied fields, covered with scrub pines, stand out as a warning against this practice.

Prior to 1860 the only occupation in this part of the State was general agriculture. Cotton was and is the staple crop, while rice, corn, potatoes, etc., were usually produced in sufficient quantity to meet the demands of home consumption. Practically no crop except cotton was sent to market. In 1853 the line now operated by the Illinois Central Railroad was built through this area, placing the people in direct communication with the Great Lakes and the Gulf of Mexico, and the future development of the adjacent country was practically assured.

The civil war delayed the development of the section many years; but at its close the people of this area began experimenting along various lines of agriculture, some growing truck, others fruit, with varying degrees of success.

In 1875 it was discovered that tomatoes, beans, peas, etc., could be grown with profit in this part of the South, and from that time the trucking industry claimed more and more attention, until nearly every farmer within easy reach of Crystalsprings or Gallman finally became a truck grower. In 1903 the industry had assumed such proportions in this area that of the total acreage of truck in the Mississippi Valley more than one-half was located within a radius of 7 miles of Crystalsprings.

All kinds of truck crops suited to this latitude are successfully grown, though the leading products are tomatoes, cabbage, peas, beans, strawberries, and turnips, of importance in the order named.

Market gardening was fostered in its infancy by a few business men at Crystalsprings, around which place it has its greatest development; but recently the towns of Hazlehurst and Gallman have encouraged the growing of truck on a larger scale, and the business bids fair to have a much larger development in the near future.

The Crystalsprings area not only has the largest acreage of truck in the Mississippi Valley, but is the largest shipping point for truck in the South. That its importance as a truck-growing district is rapidly increasing is evidenced by the fact that statistics show the number of carloads of vegetables to have risen from 523 in 1902 to 961 in 1904, a gain of 438 carloads or more than 80 per cent in two years.

CLIMATE.

While the Crystalsprings area is located wholly within the rain belt of the Mississippi Valley, and has over 50 inches of rainfall during the year, periods of drought are likely to occur during the growing season, greatly reducing the yield of crops. These dry periods usually come in July and August, when cotton and corn need a large amount of moisture. According to the observations of some of the oldest settlers, unusually wet springs are followed generally by dry summers and wet falls, and at intervals of six or eight years there may be expected an unusually cold winter and late spring.

The accompanying table, showing the normal monthly and annual temperature and precipitation, reveals the fact that most of the rainfall occurs during the months January to August, and comparatively little in September, October, and November, thus favoring the harvesting of cotton and corn. The table giving last and first killing frosts shows a growing season of seven months, beginning with April. This, together with the fact that most of the precipitation occurs in the spring and early summer, enables the farmer to take advantage of the moisture conditions and avoid the midsummer drought.

The following table is compiled from Weather Bureau records kept at Crystalsprings, situated within the area surveyed, and Vicksburg, 33 miles northwest of the area:

Normal monthly and annual temperature and precipitation.

Month.	Vicksburg.		Crystalsprings.	
	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*In.*	*°F.*	*In.*
January.....	47.3	5.54	47.7	5.79
February....	52.6	4.65	48.4	5.30
March.......	58.0	6.45	58.3	4.66
April........	65.8	5.86	65.7	4.58
May.........	72.6	4.94	73.6	4.02
June.........	79.2	4.31	79.7	5.04
July.........	81.3	4.47	81.5	6.22
August......	80.1	3.52	80.8	4.50
September..	75.3	3.49	76.2	2.42
October.....	65.3	2.62	66.6	2.49
November ..	55.4	4.85	56.5	2.98
December...	50.6	4.96	48.3	5.96
Year..	65.3	55.66	65.3	53.96

Dates of first and last killing frosts.

Year.	Vicksburg.		Crystalsprings.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1896......	Mar. 20	Nov. 9	Apr. 3	Nov. 6
1897......	Feb. 2	Nov. 17	Feb. 27	Nov. 17
1898......	Feb. 22	Oct. 27	Apr. 7	Oct. 18
1899......	Mar. 7	Nov. 3	Mar. 29	Nov. 3
1900......	Mar. 16	Nov. 12	Apr. 1	Nov. 4
1901.....	Mar. 16	Nov. 16	Apr. 21	Nov. 6
1902.....	Mar. 6	Dec. 6	Mar. 18	Oct. 29
1903.....	Feb. 19	Oct. 25	Mar. 26	Oct. 19
Average.	Mar. 3	Nov. 10	Mar. 28	Nov. 1

PHYSIOGRAPHY AND GEOLOGY.

The greater part of the Crystalsprings area is included in the main divide between the Mississippi and Pearl rivers, and has an elevation of approximately 400 feet above sea level. The area has two general slopes, one to the south and southeast, the other to the west and northwest. East of a line coinciding with the Illinois Central Railroad the drainage is southeast into Pearl River, which flows in a general southeasterly direction. West of this line the run-off is to the west and northwest into Bayou Pierre, which flows toward the northwest and west into the Mississippi River. The area thus has three physiographic divisions, viz, first, a broad ridge running in a general northeast and southwest direction and constituting the main divide; second, the "breaks" or deeply dissected slopes to the east and west of this divide, embracing the main streams tributary to Pearl River and Bayou Pierre; third, the bottom lands along the streams. The dividing ridge is about 2 miles wide at Crystalsprings, but gradually narrows toward the south, until at many places between Gallman and Hazlehurst the streams flowing east and west have cut their channels back to within less than a quarter of a mile of each other. The surface of this ridge or divide at Crystalsprings, and as far south as Gallman, is gently rolling, but becomes more rugged farther south, where it has suffered more from erosion. Some parts of this divide are so level as to be but poorly drained, but there is usually sufficient relief quickly to remove the water from the surface.

The "breaks" or dissected slopes on each side of the divide have very irregular surfaces. They are cut and carved in every direction by the large streams and their tributaries, which have their origin in deep gulches and ravines in the adjacent hillsides. These inequalities of surface vary from 10 to 30 feet near the headwaters and the narrow intertributary divides to from 100 to 150 feet adjacent to some of the main streams. Along Copiah, Brushy, Turkey, and Long creeks and their main tributaries there are thousands of acres of land still in forest and with little or no agricultural value at present on account of the exceeding ruggedness of surface. All of these inequalities have been developed by erosion, which is still very active. The streams all flow rapidly, and are continually deepening their channels. Among these hills, however, and along some of the intertributary divides are found comparatively large areas of land with topography permitting cultivation, and some parts are level enough to be worked by the use of machinery. Much farming is done on the rough land also, some of the cultivated land lying at an angle of nearly 40°.

The Crystalsprings area is well watered. Pearl River is sufficiently wide and deep to float boats of 100 tons capacity and 3 or 4 feet draft, while its tributaries are seldom more than 20 feet wide. The bottoms along the streams, however, are unusually wide as compared with the size of the streams, varying from less than a quarter of a mile along the tributaries to from 1 to 3 miles along Bayou Pierre and Pearl River. Along the last-named streams the lowlands are flanked on each side by low escarpments, which in a few places, notably northeast of Ruby and northwest of Georgetown, culminate in precipitous bluffs. In many places the escarpment almost entirely disappears, the adjacent uplands assuming a gentle incline toward the streams. Along the south sides of the tributaries of these streams the bluff lines are very pronounced, attaining at some points an elevation of 100 feet or more within less than a quarter of a mile of the stream.

The surface of the bottom lands is usually level to gently rolling. The shifting of the currents during flood time has left some inequalities, but the highest hillocks and ridges are hardly more than 5 feet above the surrounding level lands. Several oxbows and bayous occur in the bottom lands along Pearl River and Bayou Pierre. The bottom lands are often poorly drained, and are generally subject to overflow.

Nearly all the geological formations affecting the soils of this area belong to the Tertiary. The whole area seems to have been covered by a thin mantle of silty material, designated by Hilgard and McGee[a] as the "yellow loam" of the Columbia formation, though later geologists think it identical with the loess of the upper Mississippi Valley. Under this superficial covering are found the beds of interstratified sands, gravel, and clay of the Lafayette formation. The materials of which the sands and gravel are composed are always some form of silica, as quartz or chert. Both sand and gravel are well rounded, and in all probability once formed the shingle of an old shore line.

In the eastern part of the area there occurs a series of strata of interbedded fine sandstones and arenaceous shales that in all probability belong to the Grand Gulf formation. These strata affect the soils very little, however, since they come to the surface in only a few places.

SOILS.

All the upland soils of the area, except the Memphis silt loam, are developed by erosion. The Memphis silt loam, or the material from which it is derived, seems to have formed at one time a continuous mantle over the whole area, with the possible exception of the Pearl River bottoms. This superficial covering has since been so dissected by erosion that only the fragmentary remains are now found scattered irregularly over the area. The other upland soils, being developed by the erosion of materials that lie one above the other, have a rather irregular occurrence, owing to the unequal resistance offered to erosion by the beds from which they are derived. Each of the upland soils grades into the other, and well-defined boundary lines are many times difficult to trace.

Eight soil types were recognized and mapped in the area—four being upland and the four bottomland types.

Area of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Norfolk gravelly loam	48,768	32.9	Meadow	3,328	2.3
Memphis silt loam	46,016	31.2	Swamp	3,072	1.9
Waverly silt loam	25,088	16.9	Lufkin clay	448	.3
Orangeburg fine sandy loam	17,280	11.8	Total	147,840	
Waverly fine sandy loam	3,840	2.7			

MEMPHIS SILT LOAM.

The soil of the Memphis silt loam contains a large percentage of silt, is of a light-gray to yellow color, friable when in good physical condition, easy to till, and is recognized as the strongest of the upland soils. The depth of the soil varies from 2 to 10 inches. The relatively large amount of silt as compared with clay gives it some of the characteristics of a very fine sandy loam, although the sand content is negligible. The line of contact between the soil and subsoil is quite well marked. In the older cultivated areas this type of soil contains little organic matter and easily gets out of condition.

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[a] State Geol. Rept. La., 1899.

The subsoil is considerably heavier than the soil, containing more clay and less silt. It usually extends to depths greater than 3 feet and is always of a yellow or reddish color where well drained. When drainage is poor, both soil and subsoil may contain quantities of iron concretions and assume a light-gray color. For this reason it is locally called "white buckshot land."

The Memphis silt loam has great water-holding capacity, and properly managed can be made to conserve enough moisture from the winter and spring rains to tide a crop over the occasional droughts that occur during July and August.

The Memphis silt loam has light phases here and there where erosion has begun to develop one of the other types. Sometimes sandy and gravelly spots occur, which, on account of their small size, could not be shown on a map of the scale used.

By reason of its peculiar structure the Memphis silt loam has a tendency to puddle and form a surface that sheds water easily, and farmers can readily construct upon it fish ponds and small reservoirs for watering cattle. The tendency to puddle is much less on new lands, which contain larger amounts of vegetable matter.

The greatest development of the Memphis silt loam is found along the divide between the headwaters of the streams flowing east and west. The largest areal extent is found around Crystalsprings and southwest as far as Gallman. Southeast of Gallman, around the headwaters of the main branch of Copiah Creek, and about 2 miles west of Hazlehurst, along Whites Creek, are relatively large areas of this soil. Other but smaller areas of this "clay land" occur scattered at various points over the area, following narrow divides, capping hills of other types, and skirting the base of slopes. It is found to a greater or less extent all over the area in small patches of an acre or two, where, having been protected by topographic position and held in place by forest growth, it has escaped erosion. It is frequently found intermingled with the material composing the other types, giving them heavier phases than they would otherwise possess.

The surface of the larger areas of the Memphis silt loam is level to gently rolling. Occasional deep, narrow gulches are found where this type grades into one of the other types. Where the areas are small, however, there is often developed a dendritic system of drains that open out into deep ravines. There are scores of acres of this type so dissected as to be beyond practical reclamation. The soil washes readily, and where the surface is steeply inclined lack of humus, shallow plowing, absence of terraces, and ridge cultivation all combine to accelerate the denudation of the fields.

As a whole, the Memphis silt loam is well drained, but some small areas occur, notably around Crystalsprings, where skillful tiling is necessary in order to lower the water table sufficiently to grow early truck.

The Memphis silt loam is derived from a buff and yellow silty deposit, commonly known as loess, which varies from nothing to about 15 feet in depth. It is a sedimentary or transported soil, and probably little or no change in its mechanical composition has been affected by weathering, as in the deepest exposures the material has the same composition from top to bottom, except that the subsoil has a slightly higher clay content than the soil.

The Memphis silt loam is well adapted to such staple crops as cotton and corn. As a soil for vegetable growing it is found to be well suited to the production of Irish potatoes, English peas, and cabbage. It is probably the best upland soil for salad crops, asparagus, and turnips. Large yields of good tomatoes can also be produced, but they are liable to come on the market too late, except for canning purposes.

The staple crops grown on this soil are cotton and corn, with an average yield of from one-half to two-thirds of a bale of cotton and about 20 bushels of corn to the acre. Some farmers use this soil as pasture land, since Bermuda grass, carpet grass, crab grass, and lespedeza, or Japan clover, thrive upon it. Considerable trucking is done around Crystalsprings, the principal crops being cabbage, peas, turnips, and strawberries.

The average results of mechanical analyses of the Memphis silt loam, as it occurs in the Crystalsprings area, are shown in the following table:

Mechanical analyses of Memphis silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12716, 12433	Soil	0.3	1.6	1.2	1.6	2.3	75.7	16.9
12434, 12717	Subsoil	Tr.	1.1	1.0	1.5	1.6	67.0	27.7

NORFOLK GRAVELLY LOAM.

The Norfolk gravelly loam is about 10 inches deep and of a gray color. The texture varies considerably, being lighter or heavier, according as it is more or less influenced by silt from the erosion of the overlying silt loam. It always contains large amounts of sand and gravel, the proportion of the latter varying from 10 to 75 per cent. The gravel and stones vary in size from small particles to bowlders from 4 to 6 inches in diameter. The subsoil is composed of much the same material as the soil, the color ranging from gray to yellow and red.

The Norfolk gravelly loam lies wholly west of Pearl River and covers the broad slopes east and west of the main divide. It has a greater extent than any other soil in the area, and always occurs around the headwaters of and in close proximity to streams where erosion has removed the overlying silty material. The occurrence of this type is somewhat irregular, in that small patches of it are found scattered through the other upland types, and even on the bottom lands it is intermingled with the alluvium where the streams skirt the bluffs.

The surface of the Norfolk gravelly loam varies from heavily rolling to hilly and rugged, and the drainage is good. In the vicinity of all the larger streams are hundreds of acres too rough for cultivation and allowed to remain forested. The most rugged areas are found along Copiah, Brushy, Turkey, and Long creeks, where many of the ridges and hills are more than 100 feet high, with sides almost precipitous. In the western part of the area, between Long and Turkey creeks, the surface is cut into an intricate maze of ravines and gulches, with intervening ridges, hills, and knolls that are locally called mountains. Comparatively few people dwell in these rough districts.

The Norfolk gravelly loam is a sedimentary soil, derived from the Lafayette formation, which in the Crystalsprings area is composed of interstratified beds of sand, gravel, and clay. The clay content of these beds is small as compared with the amount of sand and gravel. The gravel beds are thick, sometimes attaining a depth of as much as 80 feet. There are frequent occurrences of ferruginous sandstones and conglomerates, the latter being composed of masses of sand and gravel held together in a ferruginous matrix. Its loose texture, perfect drainage, both as to air and water, topography, elevation, together with the climatic conditions and shipping facilities, make the Norfolk gravelly loam an excellent soil on which to develop the peach industry. There seems to be no reason why the production of this fruit should not be taken up concurrently with the present trucking business. There are thousands of acres of this type which are at present almost worthless except for orchards.

The usual crops grown on the Norfolk gravelly loam are cotton and corn; the heaviest phases produce good yields when the land is new, though late-planted corn is liable to be caught by the midsummer droughts. The average yield of cotton is one-third to one-half bale and of corn 10 bushels to the acre. Some farmers grow tomatoes, beans, and peas on this type, and in general the soil is an excellent one for these and other such truck crops as require a warm season. It is well suited to early potatoes, melons, cucumbers, sweet corn, and condimental plants.

The average mechanical analyses of the fine earth of the Norfolk gravelly loam, as it occurs in this area, are given in the following table:

Mechanical analyses of Norfolk gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12720, 12435	Soil	2.1	12.2	11.3	13.5	3.9	43.9	12.9
12436, 12721	Subsoil	1.7	12.6	12.3	11.9	2.9	35.7	23.8

ORANGEBURG FINE SANDY LOAM.

The Orangeburg fine sandy loam is a sedimentary soil composed chiefly of fine sand, silt, and clay, and with fine gravel frequently scattered through it. It is about 10 inches deep, of a gray color, and contains little organic matter. Like the Norfolk gravelly loam, this type has heavy phases, due to the unequal erosion of the overlying silty material. The subsoil is a red, sticky, fine sandy loam to sandy clay. It is always more than 3 feet deep and usually becomes less coherent with depth, changing to almost pure sand at 4 or 5 feet.

The Orangeburg fine sandy loam has its greatest extent in the eastern part of the survey, in the vicinity of Pearl River. Other but smaller areas occur at various points in the central and western parts of the survey.

The surface of the Orangeburg fine sandy loam is hilly and broken. Large areas of it in the vicinity of the river are cut up by deep ravines and gulches, while those areas in the central and western parts of the survey are heavily rolling to hilly, with only an occasional small area where the surface is comparatively level.

A large part of this soil is cultivated, but it is usually too steep and rough for the use of any but the simplest forms of implements. There are large areas both east and west of Pearl River that are too rough for general agricultural purposes, and are therefore allowed to remain forested. Many of the ravines are 100 feet deep, with sides almost precipitous. This soil has perfect drainage, both as to air and water.

The origin of the Orangeburg fine sandy loam is similar to that of the Norfolk gravelly loam. It is derived from the sands of the Lafayette formation, and is developed through erosion of the overlying gravel beds that give rise to the last-named type. While the materials composing the lower portions of these Lafayette beds are interstratified sands, gravel, and clay, the proportions of gravel and clay are relatively so small that they affect the soil very little.

The Orangeburg fine sandy loam is an early, warm soil and well suited to such vegetables as tomatoes, sweet potatoes, beans, and melons. Early planted corn does moderately well, and good peaches could doubtless be produced.

The staple crops of the area are those usually grown on this soil. Yields are always low, even with moderate amounts of fertilizers, the average being from one-third to one-half bale of cotton and from 10 to 15 bushels of corn per acre.

The following table gives the average results of mechanical analyses of the Orangeburg fine sandy loam:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12724, 12722.......	Soil........	0.0	1.1	5.1	44.9	4.6	33.4	11.2
12725, 12723.......	Subsoil	Tr.	.9	5.2	54.9	3.7	15.9	19.3

LUFKIN CLAY.

The soil of the Lufkin clay type is usually thin, varying from nothing, where the subsoil is exposed, to 5 or 6 inches deep. It is composed of the finer grades of sand, silt, and clay. The color is usually light gray. The subsoil is a stiff clay, containing a smaller percentage of silt, but about the same proportions of fine and very fine sand. The color varies from gray to red.

The Lufkin clay is all found east of Pearl River and northeast of Ruby. The total area is small, being less than 1 square mile. The surface is gently to heavily rolling, with an occasional deep ravine. The type has good surface drainage, but the subdrainage is poor, owing to the imperviousness of the clay.

The Lufkin clay is a sedimentary soil and is derived from the weathering of the interbedded fine sandstones and clays of the Grand Gulf formation. The type is all forested and has little agricultural value. It is probable that certain kinds of fruit, such as apples and pears, would do well on it.

The following table gives the results of mechanical analyses of the soil and subsoil of the Lufkin clay:

Mechanical analyses of Lufkin clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12714.............	Soil........	0.0	0.7	0.5	7.3	11.0	53.3	26.9
12715.............	Subsoil.....	.0	.2	.1	4.5	14.1	22.8	58.3

WAVERLY SILT LOAM.

The Waverly silt loam is the most productive soil in the area. It is usually a friable silt loam, but varies in its composition from almost pure sand, in small areas near the stream channels, to almost pure silt, over the larger areas back from the streams. Along the small streams it is usually a light soil, while along the larger ones it becomes heavier. Being an alluvial deposit, its composition naturally varies with the changing currents during floods.

The soil varies in depth from 15 to 30 inches. It is ordinarily dark-gray in color, owing to the relatively large amount of organic matter it contains, though light-gray and yellow areas frequently occur. The subsoil stratum has a thickness of from 2 to 5 feet, and is always underlain by beds of sandy material. The color of the subsoil grades from gray to yellow, depending upon the position of the water table.

The Waverly silt loam is always found along the streams, its greatest extent occurring along Pearl River, Bayou Pierre, and their larger tributaries. The surface of the type is level to gently rolling. Few of the ridges and knolls made by the shifting currents during flood seasons are more than a few feet high. In the larger areas the surface is sometimes cut by old stream channels, sloughs, bayous, and marshy places.

Practically all of the Waverly silt loam is subject to overflow, and a large proportion of that lying along Bayou Pierre is swampy and too wet for cultivation most of the year. The water table is from 1 foot to 5 feet below the surface, fluctuating with the season and amount of rainfall. Much of the type would be greatly benefited by both surface and tile drains. The streams usually flow several feet below the general level of the land, thus affording a ready natural outlet for the discharge pipes or ditches.

Much could be done to prevent overflows by straightening stream channels which at present pursue a tortuous course through the bottom lands. This is being done by individual farmers along some of the smaller streams, and a movement is now on foot for cooperation in the straightening of the Bayou Pierre.

The Waverly silt loam is an alluvial soil and owes its origin to the wash from the surrounding uplands. The material of which the hill lands are composed is clay, silt, sand, and gravel. This type has, therefore, a heterogeneous composition, but since the superficial covering of the uplands was once largely silt, this material predominates.

When well drained the staple crops (cotton and corn) make good yields on the Waverly silt loam. It is also well suited to the growth of cabbage, carrots, beets, onions, salad crops, and English peas. It has long been observed by the farmers that large crops of sugar cane were easily obtained on this soil, from 300 to 500 gallons of sirup being a not uncommon yield for an acre of land. The cane makes excellent table sirup, and recently some of the farmers and business men of the area have been arranging to develop the sirup industry along with the trucking interests. Should the production of sirup become an established industry, these low, moist, rich alluvial bottoms will return their owners many hundreds of dollars, where now large areas produce nothing.

Cotton and corn are the chief crops grown on these bottom lands. The yields range from one-half to 1 bale of cotton and from 15 to 25 bushels of corn to the acre. Good cabbage and peas are also grown. The lighter phases will produce good tomatoes and beans, but the heavier areas are too cool for crops in which early maturity is a desideratum.

The following table shows the average results of mechanical analyses of the soil and subsoil of the Waverly silt loam, as it occurs in the Crystalsprings area:

Mechanical analyses of Waverly silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12431, 12726	Soil	0.4	1.9	2.4	6.2	7.1	61.8	19.8
12432, 12727	Subsoil	.2	1.5	2.1	4.4	4.6	55.3	31.6

WAVERLY FINE SANDY LOAM.

The Waverly fine sandy loam consists of a gray-colored fine sand or fine sandy loam about 20 inches deep and containing little organic matter, underlain by a subsoil usually of the same color and texture as the soil, though it is occasionally somewhat heavier and sometimes red in color. The type in this area is a light soil and has little value for general farm crops unless fertilized.

The Waverly fine sandy loam is found in the southeastern and eastern parts of the area along Pearl River and Copiah Creek, being an alluvial type deposited by these streams. It always lies near the stream channels and where the overflow currents are swiftest. The surface is level to gently rolling, but all is level enough for cultivation with machinery. It has excellent subdrainage, and, although always subject to overflow, when the flood waters subside the water table soon reaches a point at which plants suffer no injury.

The Waverly fine sandy loam is a loose, warm soil and well suited to early truck. Tomatoes, beans, and watermelons do well. The usual crops grown are cotton and corn, with some oats. The yields are very low, except when commercial fertilizer is used.

The following table gives the average results of mechanical analysis of the soil and subsoil of the Waverly fine sandy loam as it occurs in this area:

Mechanical analyses of Waverly fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12718............	Soil........	0.0	0.6	8.8	52.1	12.7	20.3	5.3
12719............	Subsoil	.0	1.0	14.2	43.0	10.3	19.4	11.5

MEADOW.

The Meadow type of soil in the Crystalsprings area is very indefinite in its composition, being composed of small areas of both the lowland types of soil, irregularly thrown together. Some of this type is under cultivation, but a large proportion is swampy and cut by oxbows, bayous, and sloughs. It occurs along Pearl River, is subject to overflow, and has comparatively little agricultural value.

SWAMP.

The Swamp includes those large areas of land along the Pearl River that are always too wet for cultivation and are under water most of the year. They are all in forest and some have valuable timber growing upon them.

HARDPAN.

In the Waverly silt loam there sometimes occurs at from 24 to 30 inches below the surface a hardpan stratum composed of very fine sand, silt, and iron concretions. These materials are firmly compacted, so that movement of water is greatly impeded. This compact stratum sometimes comes to the surface, and such areas are known as "white oak land." It is of a light ashy gray color and always unproductive. It is probable that the best remedy for this hardpan land is deep ditching and underdrainage. Deep plowing is also recommended in areas where it comes to the surface.

AGRICULTURAL METHODS.

In the Crystalsprings area shallow plowing and cultivation are practiced on uplands, lowlands, light soils, and heavy soils alike. Ridge cultivation is universally followed and has been for fifty years past. This method of cultivation, together with the tenant system of farming, is causing thousands of acres of the uplands to become washed and eroded beyond reclamation.

All the hill lands are deficient in humus, and the bottom lands are frequently too wet for early truck or maximum yields of the staple crops. Few farmers practice any rotation in their general farming operations or appreciate the need of such practice.

The fertilizers for all the general farm crops are compounded according to the same formula, and most of the truck growers use a complete fertilizer without reference to the specific needs of the individual crops. All the fertilizers are applied before the crops are planted, and especially on the lighter soils much is leached out and lost during subsequent rains. It is the general practice to use fertilizers on all the upland soils.

There are many reasons why there should be a difference in the management of light soils and heavy soils in this area, but since a detailed discussion can not be given in this paper, it may be briefly stated that the Memphis silt loam and the Waverly silt loam should always receive deep plowing and shallow cultivation. This practice should also be pursued in the management of the heavy phases of the other types. In the management of the lighter soils of the area shallow plowing should be practiced. The plow should always run at the same depth and be followed by relatively deep cultivation. These methods will increase the moisture-holding capacity and crop yields of both the heavy and light soils. The present method of ridge cultivation should be discouraged, especially on the hill lands. In the bottoms it may sometimes be practiced with profit, since the soil is often wet and the ridges aid in securing proper drainage. The ridge method is objectionable in several respects, among others the following: First, the method greatly accelerates erosion. The ridges or corn rows, etc., are placed at right angles to the slopes, and at various points along the hillsides slight depressions occur which are crossed at right angles. When heavy rains come, the ridges conduct the water to the depressions, and it breaks over and starts a wash, which may result in a gulch during one season. It is recommended that these hill lands be carefully terraced at, say, every 30 feet, depending on the steepness of slope, and that deep, level cultivation be practiced. These terraces should usually have as much as a 1 per cent gradient and should always discharge the water into wooded glens or ravines, where grass and shrubs are growing, in order that erosion in these places may be accelerated as little as possible by this surplus water. A second serious objection to ridge cultivation is the large amount of root pruning that necessarily attends it. The plant roots are not only cut off, but the feeding ground of the plant is greatly diminished, it being compelled to develop its roots and gather its sustenance within the confines of this narrow ridge. The development of the plant is thus curtailed and the crop yield greatly lessened. A third objection is that these ridges expose a much larger surface over which evaporation takes place, and the land frequently becomes so dry that the plant foods are thrown out of solution.

Neither can the small roots live in the dry soil. Again, the beneficial effect of deep and level cultivation is apparent in that the plant roots are forced to develop deeper, and, evaporation being decreased, the moisture content of the soil is increased. On the uplands of this area, where evaporation is very rapid during the long, hot days of July and August, it is recommended that plant roots in general be not allowed to develop within less than 3 inches of the surface and that the soil below this 3-inch mulch be left undisturbed, in order that the plants may have the greatest possible feeding ground.

All the upland soils that have been under cultivation for several years are of a gray to yellow and even reddish color. These light colors are due to a deficiency of organic matter. When the lands are first cleared up they are of a dark-gray color, of loamy texture, and produce good crops without fertilizers, but a few years of shallow plowing and shallow cultivation, keeping the vegetable mold on and near the surface, soon causes this mold to oxidize or "burn out," and the once productive new lands become light colored, nonproductive, and eroded, and are finally abandoned. New fields are then brought under the plow, only to undergo the same cycle of changes. When the organic matter disappears from the heavy soils they become difficult to till, beating rains cause them to puddle or "run together," and during cold seasons they heave badly, lifting grasses and fall-sown oats out of the ground.

A systematic rotation would effect a material change, both in the chemical and physical condition of these upland soils. It is recommended that on the Memphis silt loam a four-year rotation of cowpeas, corn, cotton, and oats be practiced, while on the lighter upland soils the best rotation would probably be one of three years only, in which corn should follow cowpeas and cotton should follow corn. In any rotation on the uplands it is imperative that some leguminous crop figure prominently, and this, together with as much other vegetable material as possible, should be turned under deeply—say 8 inches—so that the content of humus may be increased and maintained in these soils.

The bottom lands do not stand in as great need of crop rotation as do the uplands, but even here a five-year rotation, in which some leguminous crop plays an important part, is recommended.

In the business of truck growing the individual must select his own rotation, which will be determined by the varieties of truck he produces; but whatever rotation he adopts must include some leguminous crop, if the greatest benefit is to be derived from the system. Some of the most successful truck growers in the area claim that with the addition of potash and phosphoric acid they can grow early crops and maximum yields of truck on land seeded the previous year to cowpeas. In this use of cowpeas not only large quantities of organic matter but much valuable nitrogen is secured. It is recommended by some of the best truck farmers in the area that no rotation be practiced in which garden or English peas, tomatoes, Irish potatoes, or cantaloupes are made to follow one another, asserting that it has been demonstrated that each of these crops may inherit the pests or diseases of the other.

In reply to the repeated question, "What kind of fertilizer shall we use on our truck soils?" it may be said that any specific recommendation, in the absence of practical field demonstration, is beyond the province of this paper. However, a few words of general advice may be given. In the first place, to get the full benefit from any fertilization good physical condition of soil and reasonably large amounts of humus are prime requisites. Having gotten the soil in good physical condition for the truck crop, there should be added, either in drill or broadcast, a certain amount—say 700 or 800 pounds to the acre, depending somewhat upon its natural fertility and previous treatment of the soil—of a mixture containing 4 per cent of available nitrogen, 8 per cent of available phosphoric acid, and 10 per cent of potash. This is designated by Voorhees[a] as a basis mixture, and may be applied to any and all market-garden crops. The specific needs of the plants are to be supplied by top dressings after the plants are up. This basic mixture may be obtained in this area by the use of cotton-seed meal, with the addition of a small amount of potash and phosphoric acid.

In the fertilization of the general field crops—cotton and corn—the most important elements to use are phosphoric acid and potash, with a small excess of the former in case of cotton. In the rotations suggested and outlined above there need be little outlay for the expensive element nitrogen, since it may be secured in relatively large amounts from the use of cowpeas and other leguminous crops. Since there has been so much published on this subject by the General Government and the various experiment stations, it is deemed unnecessary to discuss it further in this connection. Reference is made to Farmers' Bulletins Nos. 14 and 48 of the United States Department of Agriculture, and various bulletins on the same subject issued by experiment stations of South Carolina, Georgia, and Louisiana.

AGRICULTURAL CONDITIONS.

The Crystalsprings area is well supplied with shipping facilities, telephones, and rural free-delivery routes. There is plenty of excellent road metal, and most of the main roads are graded. There are many rural schools, and country churches are of frequent occurrence. But in spite of all these favorable surroundings the condition of the farming class in general is not what it should be.

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[a] Fertilizers, E. B. Voorhees.

The majority of the farmers in the area are negroes. Few produce enough on their farms to support their families during the year, and are compelled to purchase food stuffs on credit, mortgaging their future crops as security. Within the last few years there seems to have sprung up a desire on the part of the colored people to own homes, and many of them have purchased small tracts of land, of which, however, many are still under mortgage, either as security for the purchase money or for food stuffs.

The price of farm land in the Crystalsprings area has advanced rapidly within the last few years. Land that sold for $5 an acre ten years ago will sell for $10 to-day. This advance is due partly to the increase in land values generally and partly to the attention attracted to this part of the State by the trucking industry.

The small farms purchased by the colored men rarely exceed 100 acres, and usually range from 20 to 40 acres. Some of the older plantations, comprising 3,000 acres or more, are still intact. Many of these are gradually being divided into smaller farms, and the old-time large plantation is passing away. The size of the farms in this area will range from 10 to 3,000 acres, with a general average of about 60 acres.

The labor problem seems to be the most serious one in the Crystalsprings area. White laborers are few and generally unskilled. Practically all landlords depend on the negro race for help. The negro is most skillful as a cotton grower; in the growth of crops with which he is not familiar he is less satisfactory. There are, however, a great many good farm hands among the negroes, and it is largely a matter of past education and experience that they are better adapted to the more simple and easy general farming—the growing of cotton and corn—than to the more intensive business of growing market-garden products.

Much labor might be saved here by the use of improved farm machinery. There are many good farms on which machinery can be used with profit, and wherever it is possible it should be done. Some farmers are introducing machinery of various kinds. The gang plow is sometimes seen, and the cotton planter, the single-row corn planter, and other light single-horse implements are becoming quite common. In the setting of plants it would be great economy to use the improved transplanting machines which are drawn by horsepower.

The most important farm products outside of the trucking district are corn and cotton. Such crops as potatoes, peanuts, sugar cane, and rice are grown, but practically none of these is put on the general market. In the trucking district the most important products are tomatoes, cabbage, peas, beans, radishes, etc.

Of the upland soils the Memphis silt loam produces the largest yields of cotton, corn, tomatoes, cabbage, garden peas, strawberries, apples, and such other crops as require a large amount of moisture in their production. The Waverly silt loam produces good yields of long-staple cotton, corn, cabbage, peas, radishes, and also other crops requiring a large amount of moisture; but if a product is wanted early it had better be put on some of the lighter soils of the area. Tomatoes make good yields, but come on the market later when grown on these heavy soils.

The Norfolk gravelly loam is an excellent soil for early tomatoes, beans, and corn. The Waverly fine sandy loam produces good yields of watermelons, cowpeas, sweet potatoes, and Kieffer pears. The Orangeburg fine sandy loam produces good corn, sweet potatoes, tomatoes, and beans.

The Crystalsprings area has excellent transportation facilities. The Illinois Central Railroad puts the shippers in direct communication with the northern markets, as well as those of the other Gulf States, and is prepared to handle all kinds of truck crops. The company has large icing plants at Crystalsprings and Gallman, and plans are now being made to put one at Hazlehurst.

SOIL SURVEY OF TANGIPAHOA PARISH, LOUISIANA.

By **A. M. GRIFFEN** and **THOMAS A. CAINE.**

LOCATION AND BOUNDARIES OF THE AREA.

Tangipahoa Parish has an area of 504,064 acres or approximately 788 square miles, and is situated in that eastern projection of the State of Louisiana which lies to the south of Mississippi. It is included within parallels 30° 16′ and 31° north latitude and 90° 15′ and 90° 34′ west longitude.

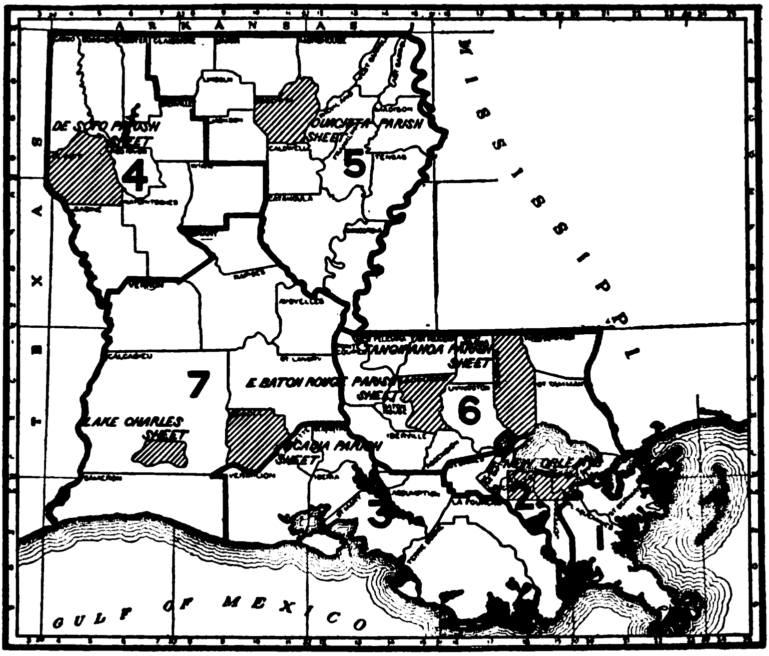

FIG. 20.—Sketch map showing location of the Tangipahoa Parish area, Louisiana.

The parish has a general long rectangular outline, and extends from the Mississippi-Louisiana line on the north to Pass Manchac and Lakes Pontchartrain and Maurepas on the south, a distance of 49 miles. On the east it is bounded by the parishes of Washington and St. Tammany and on the west by Livingston and St. Helena. Its width is 19 miles, except on both the north and south ends, where it is narrowed to 13 miles by reason of the boundaries following waterways. Hammond, with a population of about 2,500, is the largest town in the parish, and Amite is the parish seat.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Tangipahoa Parish, formerly included in the parishes adjoining it on the west and east, was not organized as a separate parish until 1871. The settlement of the larger part of the territory included in the parish has been slow and much of the parish still remains in practically a virgin state. A few settlements had been made prior to 1800 and a considerable number were established about 1812. During the Spanish régime many grants of land were made to favored citizens along the principal streams of the parish. These are recognized to-day in the form of "head rights" or irregularly shaped sections.

Ten miles of impassable swamp separated the parish from the navigable waters along its southern boundary, and water communication was had with New Orleans via Springfield or Madisonville, which are situated on tide-water streams just outside the parish to the west and east, respectively. The earlier exports consisted almost entirely of lumber, staves, tar, and other forest products. The upper part of the parish produced very small quantities of cotton, rice, cane sirup, and tobacco for home consumption only. In 1854 the New Orleans, Jackson, and Great Northern Railroad, now the Illinois Central, was run through the present parish, and this had the effect of developing the contiguous country to some extent. Before and after the civil war large herds of cattle roamed the woods and fattened upon the native grasses. For winter pasture they were driven westward toward the Mississippi and grazed in the canebrakes until spring. During this period the lands, and indeed the timber as well, were considered almost worthless, so that large areas were sold for taxes. Later, and until about 1885, lumbering in various forms was almost the sole industry of the parish, and this is yet extremely important. Large sawmills are located at Kentwood, Genesee, Natalbany, and Hammond, and since 1895 the timber has been rapidly cut. The trucking industry was started about fifteen years ago and the dairying about 1899.

As a whole, the population of the parish is native-born, but at Hammond, Roseland, and other points along the railroad are found many people from Iowa, Michigan, and Illinois. These began to arrive about 1888 and have been active in promoting the trucking and dairying interests. Immigrants from Italy form a larger part of the population in the vicinity of Independence. They are chiefly engaged in strawberry growing, are hard-working and thrifty, and are making good citizens. Many tracts of land, considered worthless for agricultural purposes, have been ditched and drained by them and are giving good results.

CLIMATE.

Reaching northward as it does for a distance of nearly 50 miles from Lake Pontchartrain, an extension of the Gulf of Mexico, and rising from sea level to an elevation of some 300 feet, the parish at its extremes necessarily presents considerable climatic differences. There are Weather Bureau stations located at Hammond and Amite. These towns are 15 miles apart and have a difference in elevation of 71 feet, the latter being the highest. The following table gives the normal monthly and annual precipitation and temperature at these two points:

Normal monthly and annual temperature and precipitation.

Month.	Amite.		Hammond.		Month.	Amite.		Hammond.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	*°F.*	*Inches.*		*°F.*	*Inches.*	*°F.*	*Inches.*
January....	51.7	6.01	53.4	4.66	August......	80.8	7.26	81.2	6.88
February...	53.6	6.06	53.1	5.16	September...	77.2	3.69	77.2	3.74
March......	61.6	5.36	61.8	5.12	October.....	66.9	2.00	67.0	2.74
April........	67.8	5.01	68.5	5.69	November...	58.7	4.15	57.4	3.93
May........	74.2	3.42	74.3	3.19	December....	52.1	4.16	53.1	4.22
June........	79.6	6.37	79.8	6.42	Year...	....	60.41	67.4	58.13
July........	....	6.92	81.6	6.38					

The Hammond records are representative of the pine flats. Those from Amite more nearly represent the conditions in the northern portion of the parish; but since the elevation of the station is considerably less than the greater part of the rolling country, it is likely that the latter figures do not show the extreme of difference between the two sections of the parish.

As will be observed from the table, the temperature in the southern portion is slightly higher than that in the northern. Moreover, the range of temperature in the latter part is greater than that in the former. The low elevation and proximity of the pine flats to the lake waters also have a tempering effect upon the winter climate. The summers are long and hot, and the higher temperatures range from 96 to 103°, but the periods of excessive heat are not of long duration. A southeastern breeze usually springs up after nightfall and gives relief from the heat of the day.

During the last eight years the average dates of last and first killing frosts at the two stations are as follows: Last in spring, March 16 at Amite, March 2 at Hammond; first in fall, November 9 at Amite, November 11 at Hammond.

Thus it will be seen that while the average growing season for the parish is about eight and one-half months, there is a difference of two weeks in its length between the pine hills and the flats. The winter temperature seldom goes below 12° F., and farm work can be carried on during all months of the year. Plowing for general farming usually begins the latter part of February and for special crops much earlier. Snow does not fall more than once in every three or four years.

The rainfall for the area is very copious and well distributed throughout the year, and except in the case of some fall truck crops, agriculture is likely to suffer more from an excess of moisture than from drought. The rainfall in the hills is somewhat greater than that in the flat lands. The greatest precipitation occurs during the three summer months, and is followed by a dry fall, with heavy, almost tropical, rains again in January, February, and March.

The prevailing winds during the spring and summer months are from some quarter of the South. High winds are likely to occur during March and April, and an occasional hurricane from the southwest destroys considerable timber and does other damage along its path.

Though the air is moisture-laden at all times and abrupt changes in temperature are frequent during the winter, the climate of the pine flats has proved to be beneficial to persons suffering from asthmatic and other pulmonary troubles, and Hammond has repute as a health and winter resort.

The general healthfulness of the area is excellent. Some malaria is experienced along the margin of the lake swamp, but the parish as a whole is free from it. This is no doubt due largely to the excellent water supply in both the hills and the pine flats. In the lower parts of the parish mosquitoes are common during certain seasons.

PHYSIOGRAPHY AND GEOLOGY.

The area consists of three physiographic divisions—a zone of flat swampy country fronting on Lakes Pontchartrain and Maurepas, the pine flats lying just to the north, and the pine hills extending north to the parish boundary. The Tangipahoa River, which enters the area on the north, flows southward through all of these divisions and empties into Lake Pontchartrain near the southeastern corner of the parish. All of the waters of the area eventually reach this lake either through the Tangipahoa or through other smaller rivers and streams. The division first mentioned has an altitude of 10 feet and occupies about 15 per cent of the entire area of the parish. It is composed entirely of cypress and gum swamps, with the exception of a small area of treeless marsh. The soils are always peaty and mucky, except in places along the shores of Lake Pontchartrain and the larger water courses, where natural levees of more earthy material have been built up.

The pine flats division of the area, which, as stated, lies just north of the division just described, is usually marked at their contact by an abrupt rise of from 5 to 15 feet, though east of the Tangipahoa River the change is more gradual. These flats occupy about 25 per cent of the whole area of the parish and have an altitude ranging from 15 to 100 feet, being characterized by their extensive broad, flat, poorly drained areas and the ashy appearance of the soil when dry. In a northerly direction there is an imperceptible but gradual rise of about 5 feet per mile, while in an east and west direction the surface is practically level, except where it is dissected by shallow water courses. The larger water courses have almost vertical banks and flow through meandering channels, with the surface of the country rising but little above them. The smaller streams have almost no banks at all, and many of them are mere swamplike depressions which serve as avenues of drainage after the heavy rains common to the region. There is, however, usually sufficient fall in some direction to insure fair drainage, provided artificial means are used.

The pine hills division of the area occupies the whole northern part of the parish and is separated from the pine flats by an irregular line running in a southeast-northwest direction. It comprises about 60 per cent of the whole area and has an altitude ranging from about 100 feet where it borders the pine flats to nearly 300 feet at the State line. Its low hills rise rather abruptly out of the pine flats and northward develop gradually into a more rolling and dissected country. In a northerly direction the gradual rise per mile is but little greater than in the pine flats region, but in an east and west direction the surface of the country is cut by stream courses running southward. The stream valleys are from 10 to 60 feet deep, but the hills may usually be referred to the same general level.

The zone of flat country referred to the first physiographic division consists of the geologic formation known as the Alluvium, which is the most recent in Louisiana, being still, though slowly, in process of building. The surface of both the pine flats and pine hills divisions consists of the Port Hudson of Quaternary age, beneath which occurs the Lafayette. The deeper stream courses, wider valleys, and more hilly, rolling character of the pine hills were developed before the Port Hudson deposits were laid down as a veneer upon the Lafayette. In the northern part of the parish, where this veneer is thin, it has been eroded from most of the hillsides, thus exposing the red Lafayette, which weathers into a more productive soil than that derived from the Port Hudson formation. The differences in the soils of these divisions are thus due to differences in the drainage conditions. The soils in each case are characterized by their fine sandy and silty nature.

From Pass Manchac northward as far as Natalbany flowing artesian wells from 200 to 350 feet deep furnish an unlimited supply of pure water, while in the rolling country bored wells from 25 to 70 feet deep are used. The clays of the Port Hudson formation are utilized at many points along the railroad for making bricks. There are several small mills and gins run by the water power of the larger creeks and it is thought there are a few locations along the Tangipahoa River where power might be developed for manufacturing purposes. The rock outcrops in the area are very limited and consist of a few patches of a coarse ferruginous sandstone.

SOILS.

The soils of Tangipahoa Parish, notwithstanding the simplicity of the superficial geology, are varied in character, and ten distinct types were established by the survey. The distribution of these soils is shown by color in the accompanying map. Their several areas are stated in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.
Monroe silt loam	196,864	39.0
Orangeburg fine sandy loam	84,672	16.9
Hammond silt loam	70,976	14.1
Peat	59,200	11.7
Meadow	55,936	11.1
Amite loam	16,320	3.3
Yazoo clay	8,896	1.8
Amite sandy loam	7,232	1.3
Marsh	3,072	.6
Norfolk sand	896	.2
Total	504,064	

AMITE SANDY LOAM.

The soil of the Amite sandy loam varies from a brown or reddish-brown sandy loam to a loamy sand of the same color, and has an average depth of about 8 inches. The subsoil varies from a heavy red sandy loam to a sandy clay. At a distance of 4 or 5 feet below the surface the color occasionally becomes yellowish, and at distances ranging from 12 to 20 feet below the surface there is usually a thick stratum of well-rounded gravel.

The Amite sandy loam occurs principally in the valley of the Tangipahoa River and is especially well developed in the vicinity of Amite, along the divide between the river and the back swamp. It is also found in patches associated with smaller streams in other parts of the parish.

This type is sometimes spoken of as "second bottom" or "hammock lands," and usually its surface features are very gently rolling.

There is generally not more than 6 or 8 feet difference in the elevation of different parts of the fields. It is rarely subject to overflow, and owing to its gently rolling surface and the character of both soil and subsoil, the rains either run off freely or are quickly absorbed. In dry weather the subsoil moisture rises easily to supply the growing crops. For the above reason it is one of the most desirable types in the area for both general farming and trucking, and its importance as a soil type is limited only by the comparatively small area which it occupies. Most of it is under cultivation.

The type is sedimentary in origin, having been formed when the present channels were occupied by larger and swifter streams. The presence of the coarse gravel substratum is evidence of this. It was a deposit along the edge of these ancient valleys. In the vicinity of Amite, along the divide between the river and the back swamp, it was formed when the high waters of the river ran over into the swamp.

The Amite sandy loam is especially well adapted to sweet and Irish potatoes and sugar cane. The average yield of corn when well cared for is about 35 bushels per acre. Cotton will average three-fourths bale per acre and sometimes more. Oats will yield from 40 to 60 bushels per acre. The soil is also a very desirable type for strawberries, cabbage, radishes, cucumbers, lettuce, beans, and other small trucking crops. Its price ranges from $20 to $60 an acre.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Amite sandy loam:

Mechanical analyses of Amite sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
12414, 13083	Soil	0.1	3.7	12.1	33.3	10.8	30.7	9.0
12415, 13084	Subsoil	.1	2.6	8.3	25.0	7.6	34.8	21.3

MONROE SILT LOAM.

The most extensive and important soil type found in Tangipahoa Parish is the Monroe silt loam. It consists of a silty or fine sandy loam, with an average depth of 12 inches. The first 3 or 4 inches is gray or brown in color, changing at that depth to a yellowish or a lemon-yellow color. Between 12 and 18 inches from the surface the material grades into a heavy yellow silt loam or silty clay subsoil, which continues to a depth of 36 inches. This occasionally has an orange color, and is frequently mottled with red, brown, or drab. Sometimes at from 30 to 36 inches a somewhat lighter, friable silt with less clay is found. Small quantities of iron concretions occur in a few localities.

The Monroe silt loam covers the greater part of the northern half of the parish and is also found in a great many small areas in the southern part, where it occurs as slight elevations in the pine flats and as strips along nearly all the stream courses. These latter areas are from one-eighth to one-half mile in width, which varies according to the size of the stream.

The topography of the main body of the Monroe silt loam is influenced by the extent to which the country had been eroded before its submergence and the deposition of the Port Hudson formation. In general, the surface is gently rolling, though nearly flat areas occur along the tops of a few of the watersheds. The extreme northern portion of the parish is somewhat more rugged than farther south, since in the former the ancient stream valleys had been cut deeper. This, however, has little effect upon the topography of the Monroe silt loam, since the steeper slopes are usually covered with another type of soil—the Orangeburg fine sandy loam.

Owing to the rolling character of the type, the Monroe silt loam possesses good natural drainage. On the other hand, the character of the soil and subsoil is such that in dry weather the type retains moisture well. In derivation it may be traced to the Port Hudson of the Quaternary period, which was an offshore deposit of material from northern regions when the country was at a much lower level and the sea extended inland many miles beyond its present limits. Since the region was elevated water has removed many of the finer particles from the top soil, thus leaving it with its fine sandy or silty character. Weathering and plant growth have contributed toward making the soil as we find it to-day.

As a rule, the pine flat areas have a slightly heavier and more mottled subsoil than the main body of the type. They are usually distinguished from the Hammond silt loam by a growth of black-jack oak and dogwood in addition to the pine. A somewhat sandier soil occurs in some of the areas and is deserving of mention not only because of its character, but also because it is in demand both as a trucking soil and for general farming. The material composing these lowland areas and their method of formation are similar to those of the surrounding Hammond silt loam. The difference in texture is due entirely to the better drainage conditions existing on the elevations and near the streams.

The older settlements of the country were not made upon the Monroe silt loam, because it was not considered well adapted to any crop. It has been highly esteemed for its valuable longleaf pine timber, but its real value for agricultural purposes has not been duly appreciated. It is only within the last few years, since the timber has been so largely removed and the agricultural population of the region has increased, that any considerable areas of this soil have been under cultivation. Eventually the main agricultural development of the parish must take place upon this soil, because of its areal importance. It is true that the type is not naturally a productive soil. The brown top soil seldom exceeds 4 inches in depth, and the organic-matter content is low. Its special value lies in the fact of its possibilities when brought to a state of productivity by fertilization and rotation of crops, combined with careful management. Its location is excellent, thus insuring good drainage; it responds readily to fertilization and holds moisture well during the summer, while its fine sand content makes it an easy soil to work. With these advantages it is well adapted either to truck growing or to general farming, and in this respect is far superior to the Hammond silt loam. At the present time it is used for all of the general crops of the region, besides such special crops as strawberries, cabbage, radishes, lettuce, tomatoes, and other trucking crops. With ordinary care and attention cotton will average about one-half bale per acre. Corn will average about 20 bushels per acre, although as much as 50 bushels per acre is sometimes grown after some highly fertilized truck crop. There is a moderate acreage in oats and satisfactory yields are secured, but the grain is not thrashed, being fed in the sheaf. Trucking is becoming a very profitable industry, and the profits from a single acre are sometimes $200 to $300 or more, depending upon the season, the market, and the care and attention given to the crops. The price of the unimproved land varies from $5 to $10 an acre, according to its distance from the railroad.

The following table gives the average results of mechanical analyses of samples of the Monroe silt loam:

Mechanical analyses of Monroe silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
11897, 11899	Soil	1.2	2.1	1.8	12.8	7.9	57.3	16.5
11898, 11900	Subsoil	.4	1.3	1.2	9.3	7.1	52.8	27.4

ORANGEBURG FINE SANDY LOAM.

The Orangeburg fine sandy loam is a dark-brown fine sandy loam, with an average depth of 10 inches, underlain by a red sandy clay. It is locally called "black sandy land," from the dark appearance of the sand in some localities. As is usual with all soils of this character that occupy hillsides, the depth of soil overlying the red clay varies considerably, ranging from 6 to 18 inches. The shallower soil is usually more or less mixed with the subsoil, which imparts to it a reddish-brown color. The areas of the deeper soil have a yellowish color, and also are likely to contain a greater proportion of medium sand than the average. Iron concretions are numerous in some localities. The sand content of the subsoil varies considerably, and in a few localities a large percentage is present. Some areas near the Chefuncte River present this phase. It is not so desirable a soil as the main portion of the type, since if drought occurs the crops are likely to suffer considerably.

The Orangeburg fine sandy loam is found only in the northern half of the area, and usually above an elevation of 130 feet. The timber growth is pine, hickory, dogwood, and several species of oak. As explained under "Geology," the soil areas represent outcroppings of the red Lafayette clays and occupy hill slopes along shallow valleys. It is therefore without exception a well-drained soil. In most cases the material forming the top soil has been contributed from two sources: The larger portion is derived directly from the underlying red clay through the removal of the clay particles by water action; the other portion consists of fine sand which has been left as a residue after the erosion of the yellow deposits of Port Hudson which formerly covered it.

Of all the upland types of the area the Orangeburg fine sandy loam is by nature the most productive. For this reason, and from the fact that the soil always occurs near a stream course of some sort, it was selected for the older settlements made in the northeast part of the parish prior to the civil war. Many of these places are still in good condition.

When the Orangeburg fine sandy loam is not situated upon too steep a hillside, it is a very desirable general farming soil. At the present time a large proportion of it is not under cultivation. Here the covering of grasses and other natural growth has protected it from washing, but many examples of serious erosion were observed in the cleared fields, and, in general, too little attention has been paid to this waste.

When well fertilized the Orangeburg fine sandy loam produces an average yield of 20 bushels of corn and one-half bale of cotton per acre. It is a good peach soil, and the leveler portions are suitable for truck, but it has not been used for these purposes to any extent.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Orangeburg fine sandy loam:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
12437, 13095	Soil	0.5	5.0	13.9	25.8	12.3	30.2	12.0
12438, 13096	Subsoil	.1	2.6	9.5	25.0	8.8	21.3	32.1

NORFOLK SAND.

The Norfolk sand, to a depth of 8 inches, consists of a brown or reddish-brown medium sand. The subsoil to a depth of 36 inches is similar in general character, but lighter in color and usually a little less loamy. The soil is quite uniform in texture, but the color varies and some areas have a yellowish color. At about 30 inches the subsoil frequently grades into a coherent red sand containing considerable clay.

This type has less extent than any other found in the survey, and the individual areas occupied by it are very small. A few of them are found as deposits along the larger streams, but the majority occur in a series of peculiar sand mounds in the pine flats. Their size varies from 2 to 30 acres and their elevation above the surrounding country is from 6 to 20 feet. They jut up at short intervals along a single line, 11 miles in length, which extends along the west side of the Tangipahoa River at a distance of from 1½ to 2 miles. Surrounded as they are by a soil composed of totally different materials, the exact origin of the mounds is hard to explain. It is likely, however, that they were formed by stream currents before the deposition of the top member of the pine flats, when the country was below sea level.

The limited extent of the Norfolk sand makes it agriculturally unimportant. It is a well-drained soil, and the larger areas are under cultivation. Some truck is successfully grown upon them, especially on the lower slopes of the mounds, where the soil is somewhat mixed with finer materials. Cotton produces about one-half bale per acre when well fertilized. Fruit trees do especially well. The natural growth is scrub oak and pine.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Norfolk sand:

Mechanical analyses of Norfolk sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
12159	Soil	0.0	5.7	31.3	44.8	4.6	9.3	4.0
12160	Subsoil	.0	5.7	28.1	40.5	4.1	13.7	7.5

MARSH.

In the southern part of the area, between the highland and the lake swamp, there is a strip of treeless swamp country varying from one-fourth mile to a mile in width, and known as the "prairie" or "marsh." This has been mapped as Marsh. The surface covering for several inches consists simply of a mass of grass roots. Under this is found a black silty clay containing a high percentage of organic matter, the depth of which varies considerably in different parts of the several areas, ranging from 5 or 6 inches to 3 feet or more. Beneath the black clay a drab or bluish clay appears, fairly uniform in texture, and reaching to a depth of 8 or 9 feet, where a considerable quantity of white sand is mingled with the clay. Observations made near alligator holes indicate that at a lower depth pure sand would be found.

The Marsh supports a growth of coarse grass, which affords some pasture. It is only a few feet above sea level, and except for short periods during the summer it is covered with fresh water the entire year. A growth of cypress and gum surrounds the area on all sides, and is gradually encroaching upon the treeless portion. Old residents assert that within the past forty years the area has been built up nearly 3 feet. The filling material is derived principally from several small streams which empty their sediment-laden waters directly upon its surface.

At the edge of the highland bordering this type on its northern side there is found a well-defined beach line, probably an earlier though comparatively recent boundary of Lake Pontchartrain, so that the soil probably formed the bottom of the northern part of that body of water when it was more extensive than at present.

The Marsh is an important type, not because of any present use, but because of the undoubted agricultural value of the soil when reclaimed, a project which is feasible in all but a small part of the area. At the present time a large area of similar soil in an adjoining parish is being diked, ditched, and fitted with pumping apparatus, and will be in cultivation by the end of the year. Rice and sugar-cane will probably be grown. A small area in Tangipahoa Parish was reclaimed a few years ago and sowed to rice with excellent results, 175 sacks being obtained from an area of less than 20 acres.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type.

Mechanical analyses of Marsh.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
12167	Soil	0.0	0.2	0.4	2.9	9.1	66.4	21.0
12168	Subsoil	.0	.0	.2	4.2	15.3	62.4	17.5

MEADOW.

The Meadow consists of low-lying and swampy areas of the upland which, because of their variable character, could not be satisfactorily classified or mapped as separate types of soil. It is all subject to overflow during the winter and spring months.

The largest continuous area of Meadow, known as the River Swamp, is found along the Tangipahoa River. It averages nearly a mile in width through almost the entire length of the parish. The character of the soil material of this river bottom is exceedingly variable, and its surface is cut by many old stream channels and bayous. Large deposits of sand and gravel occur at various points along the stream, especially in the lower part of the parish. Farther up the stream some areas have nearly a clay soil, and there are also many detached areas which are identical in character with the Amite loam. At the present time these are covered with a heavy growth of beech, magnolia, poplar, and some pine. Eventually they will be cultivated and will make exceedingly valuable soils. The expense of clearing the land has been one cause for their neglect. After April 1 the danger of floods is usually past and these tracts are high enough above the stream to provide for excellent drainage during the remainder of the year. Aside from the large area described, little Meadow occurs in the hill regions.

The areas of Meadow in the pine flats, which are very numerous, occur either as strips along the shallow streams or in the form of swamps varying from a few to several hundred acres. They are covered with gum, willow, water oak, bay, holly, and some pine, and their limits are always sharply defined by the change from this growth to the open forest of the piney woods. In very few cases is their drainage and cultivation practicable. The soil is usually of a gray silty nature, and while it would be suitable for rice, its value for other crops is doubted. The largest area of Meadow in the pine flats is situated to the west of Amite, and is known as the Black Swamp. Its general character is similar to the other areas, although the soil is heavier than the average, and the elevation in places slightly higher than usual in these depressions. The more elevated areas would be productive and could be easily reclaimed and put into cultivation. The Black Swamp is covered with beech, chestnut, oak, magnolia, bay, poplar, and some shortleaf pine.

AMITE LOAM.

The Amite loam is the only real bottom soil under cultivation in the parish. The soil consists of a dark-brown or nearly chocolate colored loam from 6 to 10 inches deep, and often contains thin seams of fine sand. The subsoil is a yellowish or reddish clay loam, which has a uniform texture to a depth of 36 inches.

The soil occurs only as flood plains of the larger streams in the upper part of the parish. It is likely that the larger portion of the subsoil consists of a deposit, in the previously eroded valleys, of material similar to that covering the surrounding hills. The soil has been formed of the silt and fine sand carried in from the surrounding hills and spread out over the terraces in times of overflow. The soil itself is quite uniform in different parts, but the areas in which it occurs are not so. They are often badly cut up and contain swampy places, as well as small deposits of sand and clay. Where such places were numerous or the area was much cut by old stream channels it was mapped as Meadow.

The Amite loam is a valuable soil, but is of little importance in the area because of its limited extent. Much of it is not yet under cultivation. The areas are overflowed during the winter, but there is no danger from this source during the growing season. The soil is the best corn soil in the parish and produces from 30 to 40 bushels per acre. When fertilized cotton yields from two-thirds to 1 bale per acre. Cabbage, sugar cane, radishes, and other crops do proportionately well.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Amite loam:

Mechanical analyses of Amite loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
12439, 13081	Soil	Tr.	0.8	2.4	15.9	7.5	50.6	22.6
12440, 13082	Subsoil	Tr.	.7	1.9	10.3	4.3	50.0	32.5

PEAT.

The area classed as Peat comprises the larger proportion of the lowland swamp bordering Lakes Pontchartrain and Maurepas in the extreme southern end of the parish. For a depth of 3 feet or more the material composing the swamp is simply a brown peaty mass of decayed vegetation, containing many root fibers and having a putrid odor. In certain parts of the swamp a light-drab clay was found underlying the peat at a depth of from 7 to 9 feet, but it lies usually much deeper than this. Most parts of the Peat are covered with some standing water at all seasons of the year, and it is so nearly at sea level that during periods when a southeast wind blows the water from Lake Pontchartrain backs up along the bayous and overflows these lowlands to a depth of 2 to 3 feet. They are at all times boggy and in places nearly impassable.

It is evident from this description of the Peat that the Mississippi sediments have had little influence upon its surface character. The greater part of the soil has been formed by the decay of the luxuriant vegetation. In this respect it differs from those large swamp areas which comprise the greater part of the Mississippi delta. The latter consist principally of heavy clays, and the peat or muck areas are of merely local extent.

The Peat is covered with a dense growth of cypress, black gum, tupelo gum, some soft maple, willow, and an almost tropical growth of underbrush and vines. In the higher portions along its edges the palmetto grows to great size. Most of the cypress for some distance back from the waterways has been cut and removed by means of "pull-boats"; that farther from the shore will eventually be reached by means of "skidders" run in on light tramways.

Agriculturally the Peat has little value. The unstable character of the soil and subsoil makes it unsuited for successful diking. In addition to this the soil is so nearly pure organic matter that only special crops could be grown upon it. Before the value of the timber was realized, much of the swamp was purchased from the Government at 25 cents an acre. The present market value of the areas supporting cypress timber is from $10 to $12 an acre.

YAZOO CLAY.

At the edges of the lake swamp, along the water fronts, and upon the highland side, there is found a heavier soil than that composing the main swamp area. Its character is exceedingly variable. The strip along Pass Manchac consists of a heavy brown clay loam with a depth of 8 or 9 inches, underlain by a sticky bluish or drab silty clay. The materials are somewhat similar along Lake Pontchartrain, but there considerable fine gray sand enters into the composition of the soil along the immediate shore. The soil of the type along the banks of the Tangipahoa River is slightly heavier, and the subsoil is a yellowish mottled clay. A larger area occurs in the neighborhood of the point at which the Tangipahoa River enters the swamp from the highland, and here the soil is a heavy brown silty clay, with considerable organic matter, with the subsoil similar in texture, but lighter in color.

The areas of Yazoo clay along the water fronts consist of natural levees built up by sediments in times of flood. They are slightly elevated and grade into the swamp from one-sixteenth to one-eighth of a mile back from the shore. In addition to the usual swamp growth, ash, live oak, and willow are found growing upon them. Several very large shell banks are found associated with the shore at the mouth of Tangipahoa River. A few gardens represent the entire use of the soil for agricultural purposes.

The areas on the highland side of the swamp are formed by sediments brought down by the Tangipahoa River and smaller streams and spread out over the swamp. They are covered with a dense growth of gum and are under water for the greater part of the year. At present they have no agricultural value.

The following table gives the results of mechanical analyses of the Yazoo clay:

Mechanical analyses of Yazoo clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
12165	Soil	0.0	0.5	0.7	7.9	14.4	50.5	26.0
12166	Subsoil	.0	1.0	1.2	3.2	3.0	67.8	23.6

HAMMOND SILT LOAM.

The Hammond silt loam is a silty or fine sandy loam with an average depth of 15 inches. The surface has an ashy-gray appearance, which becomes dark-gray or brown when wet. This gray color may continue for the entire depth of the soil, but it frequently changes to a yellowish color at 4 or 5 inches from the surface. The subsoil is a heavy silty clay of a yellowish color, with drab, brown, or red mottling. A few iron concretions are found, but they are not a distinctive feature of the soil. The transition from soil to subsoil is usually gradual. During dry weather the soil does not hold moisture well, but bakes hard, and when powdered becomes almost white with a chalky appearance. Occasional small low swales or savannas are found, the soil of which has a brown or nearly black color.

The Hammond silt loam forms the main part of the pine flats region, and in smaller areas extends along some of the larger streams. It occupies broad, level interstream areas, broken only by an occasional swell or swampy depression, and its main body occurs between elevations of 15 and 100 feet. The drainage conditions over the greater part of the type are poor. Stream courses are numerous, but their channels are so immature that their influence as direct drainage factors extends but a short distance back from the stream. In addition to this the impervious character of the clay composing the subsoil does not allow the free passage of water by means of seepage, and during the winter water stands upon many parts of the area for long periods. Crawfish are more or less plentiful throughout the area of this type of soil. In winter the unimproved roads are soft, though not boggy.

In its broader area the type is quite uniformly a silt loam, but the smaller areas frequently show considerable variation, so that both a lighter and heavier phase are found. The latter occurs principally near the lake swamp, especially where the transition from the pine flats to the alluvium divisions is gradual. The soil is shallower and the subsoil considerably heavier than in the main body of the type. It has little agricultural value. The lighter phase is not very extensive, but somewhat more important. The soil is very similar in appearance to the main portion of the type, but is distinctly a fine sandy loam and in addition has a variable heavy sandy loam subsoil. It is found to some extent in the vicinity of Independence and elsewhere in small areas, and is especially well adapted to strawberries and truck.

A minor phase of the soil also occurs as slight depressions or very flat stretches in the rolling areas of Monroe silt loam. Except for the subsoil, which is more a silty loam than a clay in character, these smaller areas are similar to the main portion of the type. None of them is under cultivation.

The drainage of field upon Hammond silt loam is one of the principal factors in successful cultivation. At present comparatively little has been done in this respect, but illustrations of its value are not lacking. The success of many farmers in the Italian colony about Independence has been due largely to care in drainage, and the more productive areas along stream banks serve as natural illustrations. As yet the country is not settled sufficiently to warrant the construction of large trunk ditches, but eventually this method of drainage should be used. Some areas, especially about the heads of streams, are difficult to drain in any manner, but between stream courses there is usually sufficient fall to provide for the removal of surplus water. In the meantime the fields should be plowed in narrow lands for general crops, and in addition to this, in a large number of cases, open ditches should be constructed. With proper drainage and fertilization the type may be brought to a state of productivity.

The Hammond silt loam is derived from the Port Hudson clays, composed of marine sediments. The soil proper has been modified by weathering and by plant growth.

The natural forest growth upon the Hammond silt loam is almost exclusively longleaf pine, the greater part of which has been cut away. The second growth and the timber of the low-lying areas are mostly loblolly or shortleaf pine. Palmetto and some oak are found near the swamp.

The Hammond silt loam is very deficient in organic matter and is naturally a very poor soil. This fact, added to its poor drainage conditions, formerly caused it to be held in very low esteem for all farming purposes, and it has been only a relatively short time that any considerable areas have been under cultivation. Cotton has not been grown upon it with success and corn is usually a failure. Oats will yield from 40 to 60 bushels per acre, and crab-grass hay, sugar cane, and small truck do fairly well, but the crop to which the largest acreage is devoted at present is strawberries. In a good year from 300 to 400 cases per acre can be produced and a profit of from $75 to $200 or more realized. All these crops have to be heavily fertilized to obtain satisfactory results. During the last few years dairying has been developed upon this type in the vicinity of Hammond. Excellent pasturage is afforded during the spring and summer months.

The price of land in the Hammond silt loam areas varies from $5 to $15 an acre, according to its location. Near the railroad at Independence some tracts have been sold at from $50 to $75 an acre, but these prices are exceptionally high.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Hammond silt loam:

Mechanical analyses of Hammond silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
11667, 13085	Soil	1.4	1.8	1.6	9.2	23.1	50.8	11.8
11668, 13086	Subsoil	.1	.6	1.0	8.8	16.4	43.1	27.7

AGRICULTURAL METHODS.

The methods employed in trucking, which is now the leading agricultural industry in the parish, have been worked out through experience, and are well understood, at least by the older growers. There are two prime requisites necessary for the success in this business: First, thorough preparation for and cultivation of the crop, and, second, intelligent application of fertilizers. Strawberries form the chief truck crop. The plants are transplanted during the months of August to November, inclusive. They are set in rows upon beds raised 6 inches above the intervening dead furrows, and at the rate of 12,000 to 14,000 plants to the acre. The Klondike berry, grown at present, has excellent shipping qualities, though not a sweet berry. The beds are allowed to bear from one to three years. Before bedding the soils should receive at least two plowings, and an application of fertilizer has been found to be necessary to produce the best results. The plants set in August grow larger, but those set in November are said to produce the better berry. The vines are mulched with pine straw in January and February, and the berries begin to ripen the last week in March.

In growing strawberries commercial fertilizer is used, it being thought that stable manure impairs the shipping quality of the fruit. This continued use of commercial fertilizer assists little in the permanent building up of the soil, and in case it is desired to grow other truck crops on the sandy land but little benefit from previous applications may be expected. For vegetables some stable manure is a necessity and little hope for success without its use can be entertained. It is delivered at the stations along the Illinois Central Railroad at the rate of $9 a car, and its use should be general, both for truck and general farming crops.

Where cattle are kept a combination of the truck and dairy business has proved profitable. It is usually necessary to buy considerable feed during the winter, but the dairyman is continually building up his land by the use of stable manure, and the increased crops he receives are said to more than pay his additional feed bill.

Irrigation in the lower section of the area has been employed to some extent, especially for use with fall truck crops, but as yet it has not received the attention it deserves. The importance of keeping such crops growing rapidly is considerable, and the ease with which artesian water can be piped to any part of the field makes its use practicable and cheap. Even higher up in the parish, where water has to be pumped, it is probable that its use will be found profitable.

There are shippers' associations at Ponchatoula and Roseland, and these have aided materially in securing cheaper transportation rates and a uniformity in methods of packing and making shipments. All goods sent through the association are consigned to one man in Chicago, who acts as distributing agent. Most of the goods are shipped on commission. Some berries are sold for cash at the station, and upon the whole this seems the best method with very perishable products, for while the price is somewhat lower than the market, all risk of poor returns because of damaged or delayed shipments is avoided.

Throughout the general farming portion of the area the cattle are bred neither for milk nor beef. There is here also a general lack of appreciation of the value of barnyard manure, the stock being usually allowed to run at large, and no attempt being made to save the manure during any part of the year. The importance of stock raising as an adjunct to nearly every kind of farming, where the manure is judiciously saved and applied to the tilled fields, can not be overestimated.

The Orangeburg fine sandy loam is practically the only soil in the area which is subject to serious washing. In recent years the practice of contour cultivation has been followed to some extent on this soil. This is a step in the right direction and in some cases all that is needed to correct the washing, but many of the fields are so situated that nothing less than permanent terracing will be efficient. The presence of many stumps in the cleared fields also tends to cause much washing. Where many of them are present the contours can not be properly followed, and breaks in the rows are bound to occur. As a rule, this soil is not cultivated below a depth of 3 or 4 inches, and it is seldom that the red clay subsoil is disturbed. In most areas the type will stand much deeper plowing.

With certain notable exceptions there is in the part of the area where general farming is practiced a lack of appreciation of the value of deep plowing and thorough preparation of the land. Even farmers who know that trucking requires this do not seem to realize that the same principles hold true for all crops. A light single-horse plow is still in general use even in breaking new ground. Since the depth of the seed-bed in succeeding years usually depends largely upon the first plowing this should be 6 inches or deeper in most of the soils. It is true that too much of the subsoil brought to the surface the first year may reduce the crop somewhat, but the better results in subsequent years will more than offset this temporary disadvantage.

While the value of systematic rotation of crops generally is recognized, the practice of rotation is by no means common. In some cases cotton is followed by corn, with cowpeas sown in the corn at the last plowing. Oats, sown in the fall and harvested in May, will prove a good crop and should be more generally grown. The fact that the few livery stables in the parish have to import both hay and grain indicates the lack of interest in the production of feeding crops. The proportion of farmers growing corn sufficient to carry them through the year is probably between one-half and two-thirds. Very little attention is paid to the selection of either corn or cotton seed.

AGRICULTURAL CONDITIONS.

That portion of the parish west of Tangipahoa River is the more highly developed, not because of any difference in the soil conditions, but by reason of the better transportation facilities. The larger part of the parish is still in a state of transition from a community whose main interest was centered in some form of lumbering to one in which agriculture is the chief occupation. For many the change is hard to make, since the work is new and the soils do not always respond readily to the first years of cultivation. It is also difficult for the older agricultural settler to accustom himself to the new and changing conditions. Formerly his stock ranged over thousands of acres not necessarily his own. He lived on a small clearing, growing a few necessities of life, and was content with his few acres. At present many of these older men complain bitterly of the curtailed range for their stock, and some even decry the settlement of the parish and the building of railroads.

Roughly speaking, the agricultural population of the parish may be divided into two classes—those pursuing general agriculture and the truck growers. The latter are naturally confined to a strip some 5 or 6 miles wide on each side of the railroad. The farm buildings in this section are above the average for the rest of the parish, and the houses are usually painted. In the remoter parts of the parish many of the buildings are characteristic of a newly settled country and are usually poor. Often shelter for stock is wanting entirely:

The majority of the farmers in the truck business are out of debt, and the status in this respect for the entire parish is good. The percentage of mortgages on farm property is small.

The farms throughout the parish are operated almost exclusively by the owners, this being so largely because land is plentiful and cheap. The public land for homeseekers has all been taken up, but farms can be purchased very cheaply. The size of farms varies in different parts of the area, depending upon whether general farming or trucking is pursued. Far removed from the railroad the farms range from 60 to 100 acres in size. Near the railroad, where trucking is becoming quite universal, they vary from a few to about 50 acres in extent. The large lumber companies have holdings ranging from 1,000 to 40,000 acres. A large part of this was bought for prices ranging from $1.25 to $3 an acre, and is now worth $12 to $15. It is thought by some that these large holdings retard the agricultural development of the area, while others believe that when once the timber is removed these lands will be put upon the market at a reasonable figure, and that the region will develop more rapidly than if it had not been first exploited by the lumbermen. In the central part of the parish there are large areas of pine still standing. At the present time it is estimated that between 8 and 10 per cent of the parish is under cultivation.

During the last decade there has been a general scarcity of farm labor in the parish, due largely to the fact that more profitable employment can be obtained in the sawmills and upon public works than upon farms, since at the usual price for general farming products the farmer can not afford to pay more than from $10 to $15 a month and board. When general farming is pursued, the labor is generally performed by the owner and his sons. Where trucking is followed, it is necessary to employ a great deal of labor during a portion of the year, but the prices obtained for trucking products are usually high enough so that liberal wages can be paid. The native negro labor is the best that can be obtained. Many of the Italians work by the month for the first year or so they are in the country, and they are said to be very satisfactory as laborers. It is not long, however, before they are operating small truck farms of their own. The present movement for a diversion of a portion of the foreign immigration toward the Southern States should eventually make farm labor more abundant. The negro population of the parish is about one-third of the total, and is mostly centered in the towns.

The principal products in the general farming portion of the area are cotton, corn, oats, sirup, cattle, and hogs, while along the railroads the products are strawberries, cabbage, beans, radishes, lettuce, cucumbers, tomatoes, potatoes, and dairy products. The total cotton crop of the parish in 1904 was about 10,000 bales, and the average yield slightly under one-half bale per acre. Where grown it is the chief money crop, while corn and oats are consumed on the farm. At present the value of the truck shipments exceeds that of all the other farm crops combined. In 1903 the express company forwarded 350 cars of strawberries from Independence, Hammond, and Ponchatoula, in addition to which over a hundred cars of berries and truck were handled by the railroad company as freight.

The dairy business in the vicinity of Hammond is important and promises to increase with the location of a suitable receiving station at that place. At present the daily shipments of milk to New Orleans are about 1,500 gallons, for which 15 cents a gallon is received in winter and 13 cents in summer. The daily milk consumption of New Orleans is about 12,000 gallons and a much larger proportion of this amount should be furnished from this area.

At the present time tree fruits are not grown to any extent. There is opportunity for peach growing in the northern part of the parish, and with a certain amount of protection by cornstalks and pine boughs during the winter certain varieties of oranges and tangerines can be grown in the southern part. One orchard of 20 trees was observed from which the owner sold $120 worth of fruit the fourth year. Some Japanese fruits, including plums, also do well. Pecans might be profitably grown.

The unsettled portions of the parish still afford a wide range for cattle and hogs for about nine months of the year. Numbers of sheep are also pastured, but are not especially profitable. Other products consist of large quantities of pine and cypress lumber and turpentine.

The earlier settlements of the parish were usually made along stream courses upon the Orangeburg fine sandy loam or Amite loam, and as a rule the first crops grown were well adapted to these soils. The Monroe silt loam was not considered a good soil, but is now being recognized as a safe and profitable type for cotton, corn, oats, and truck crops. Strawberries do best upon newly cleared land, either Monroe silt loam or Hammond silt loam, though the quality of the berry is slightly better upon the latter and most of the berries are grown upon it. Other truck crops do not do so well upon it, except upon the drier and more sandy portions, and it is not a good soil for cabbage, cucumbers, tomatoes, corn, or cotton.

The Amite sandy loam is well adapted to all crops of the area. Alfalfa has been tried upon the Hammond silt loam, but the soil is usually too low and wet for it to succeed. It should, however, do well upon the Monroe silt loam.

The excellent transportation facilities furnished by the Illinois Central Railroad have been the controlling factor in the development of the truck business of the parish. Chicago, the market to which most of the products go, is reached in thirty-six hours by express and in sixty hours by freight, while New Orleans is only two hours distant. During the strawberry season, which lasts for about six weeks, a special refrigerator express train is run northward every evening, and there is usually excellent cooperation between the railroad and the growers in the matter of shipments. St. Louis, Cincinnati, and Milwaukee also receive a small part of the products.

The eastern portion of the area is somewhat isolated at present. There are several log tramways which cross the parish from east to west and connect with the railroad. After the timber is removed it is believed some of these will become passenger and freight carrying roads and will assist in the development of this section of the country. A few of the wagon roads of the parish have been improved by the simple and cheap method of crowning the center with material from the sides, and an excellent road, both in summer and winter, is the result. Oxen are used for all heavy transportation.

One reason for the present and undoubted future success of the parish in the truck and berry business is its geographical and climatic position. Its products are not the earliest upon the market, being preceded by those of Florida and Texas, but they begin at a time when there is a greater demand for early vegetables than the first shipments receive.

There can be no question that within the next few years a rapid and yet normal development will take place in the unsettled portions of the parish. The larger part of the parish is composed of soils capable of being brought into profitable cultivation, while the climate is healthful and the water pure. The center of the parish is but 60 miles from New Orleans, at present the metropolis of the South and rapidly growing. It is also upon the main line of travel between the Central States and New Orleans, and the only highland parish north of the city possessing this advantage.

SOIL SURVEY OF EAST BATON ROUGE PARISH, LOUISIANA.

By CHARLES W. ELY, HERBERT W. MAREAN, and N. P. NEILL.

LOCATION AND BOUNDARIES OF THE AREA.

East Baton Rouge Parish is located in the southeastern part of the State of Louisiana. The Mississippi River forms the western boundary, while the parish of East Feliciana lies immediately to the north, St. Helena and Livingston to the east, and Ascension and Iberville to the south. The Amite River flows along the eastern boundary. Baton Rouge, the county seat and the capital of the State, is situated on the Mississippi River, in the southern half of the county, and is 89 miles distant from New Orleans by the Yazoo and Mississippi Valley Railroad. The parish is irregular in shape and contains 288,512 acres, or about 451 square miles.

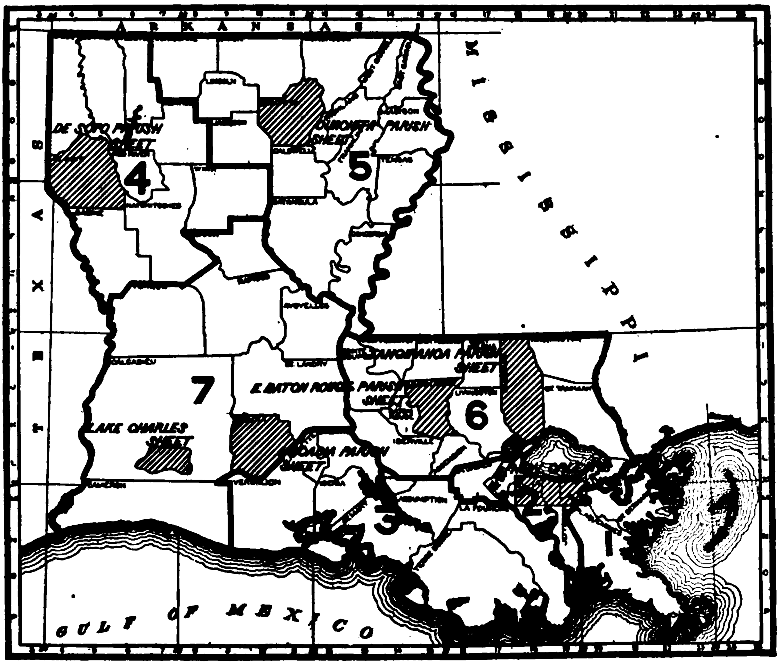

FIG. 21.—Sketch map showing location of the East Baton Rouge Parish area, Louisiana.

The base map used for the northern part of the parish was furnished by the United States Geological Survey, but the remainder of the parish was covered by a plane-table survey made by the soil survey party in the field.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The territory covering the area of the present survey was ceded to the United States by the French in 1803. West Florida, as it was known, was taken possession of by the governor of the Territory of Orleans, or what is now Louisiana, in 1810. This was soon afterwards divided into parishes, of which East Baton Rouge was one.

The first white settlers within East Baton Rouge Parish were compatriots of the French who founded New Orleans. A number of Acadians, who were expelled by the English from Canada, reached New Orleans in 1759, and a great many finally settled within the present limits of the parish. By 1803 Baton Rouge had become a town of some importance. Soon after the battle of New Orleans glowing accounts of the richness of southern Louisiana, spread by Jackson's soldiers and river boatmen, came into circulation and a great many planters from Georgia, Alabama, and neighboring States rushed in with their negroes, and from then until 1825 or 1830 settlement was very rapid and the country is said to have been very prosperous. Naturally the first lands settled were near the river, where transportation was easy; away from the main streams the development of the country progressed slowly. Even at the present time there are considerable areas of land in the northeastern part of this parish capable of cultivation, on which virgin timber is growing, and it is not hard to find persons who can remember when large areas now under cultivation were in forest.

The railroads in the parish are of comparatively recent date, and even these, as they follow a line not very far from the Mississippi River, have never had the effect in developing the country that railroads have had in other places.

Indian corn and tobacco were the first crops grown in this section. Cotton naturally did not attain much importance until after 1792. Sugar cane was introduced into the State in 1751, but was not very successful until De Bore discovered a process for granulating the sugar in 1795. Rice was another early crop, as was also indigo. Since the beginning of the nineteenth century cotton and sugar cane, more especially cotton, have been the main crops grown in the parish. Cotton was a crop easily grown under slave labor and was found very profitable. The civil war changed conditions and ruined many planters, and though probably those in East Baton Rouge Parish did not suffer so severely as in many parts of the South, the war gave agriculture a serious setback, from which it is only now recovering.

From the close of the war until twenty or twenty-five years ago there ensued a period of adaptation to the new conditions and of very little agricultural development. Recently there have appeared some signs of an awakening. Japanese clover and alfalfa have been introduced and in a general way the farmers are beginning to realize that they are growing too much cotton, and it is probable that the diversification of crops will be more marked in the future.

CLIMATE.

The following table, compiled from the records of the Weather Bureau at the experiment station near Baton Rouge, indicates the normal monthly precipitation and temperature of the region. As a rule, the climate is characterized by excessive precipitation in winter and early spring, and by drier weather in summer. The ground often becomes hard and difficult to plow in late fall. The last frost in spring comes about the middle of February and the first in fall about the middle of November, which gives a growing season of approximately two hundred and forty days, and no great amount of damage is ever done by frost, though occasionally early oats are killed and sugar cane is sometimes damaged.

Normal monthly and annual temperature and precipitation.

Month.	State experiment station.		Month.	State experiment station.	
	Temperature.	Precipitation.		Temperature.	Precipitation.
	°F.	*Inches.*		*°F.*	*Inches.*
January	51.5	5.11	August	81.7	5.68
February	54.6	4.86	September	77.6	3.42
March	60.9	4.97	October	67.9	3.28
April	68.2	4.81	November	59.2	3.70
May	74.7	2.27	December	52.1	4.90
June	79.4	5.83	Year	67.4	54.61
July	81.5	5.78			

Dates of first and last killing frosts.

Year.	State experiment station.	
	Last in spring.	First in fall.
1901	Mar. 7	Nov. 17
1902	Feb. 25	Dec. 5
1903	Feb. 18	Nov. 19
Average	Feb. 26	Nov. 24

PHYSIOGRAPHY AND GEOLOGY.

East Baton Rouge Parish is naturally divided into two main physiographic divisions—the Mississippi flood plains and the uplands. The two sections are distinctly separated by the river bluffs, which rise abruptly from the alluvial bottom to the loess-covered plains above.

From the city of Baton Rouge to a point about 6 miles north the bluffs border immediately upon the river. The bottoms are thus divided into two sections. The northern section is of somewhat limited extent, unprotected by levees, and swampy, and consequently of little importance agriculturally at the present time. The larger area lies to the south and southeast of Baton Rouge. This is diked and, excepting the swampy places, is all under cultivation. It presents the characteristic features of the Mississippi flood plain, a nearly level belt of country from 2 to 5 miles broad, sloping gently from the stream banks inland to the bluffs, the "natural levee" of the river banks being the highest portion. A sluggish bayou flows along the foot of the bluffs, carrying the drainage of the bottoms ultimately into the Amite River. Along this stream there is a belt of swampy land of greater or less extent.

The upland division is characterized by a level to gently rolling topography, with a limited area in the northwestern corner which is rolling or hilly. The river bluffs reach their greatest height at Port Hudson, on the northern boundary of the parish, where they rise abruptly to a height of 80 feet or more. From that point they gradually become lower until in the southeast corner the elevation is not more than 20 or 30 feet above the bottoms.

The general slope of the upland is to the southeast. It has the general slope of the country toward the Gulf, and, besides, a slope away from the river, which is characteristic of many river bluff lands. The drainage of the larger part of the area is to the southeast into the Amite River, only a narrow zone along the bluffs being tributary to the Mississippi. This zone reaches its greatest width—about 5 miles—in the northwestern corner. Here the streams have cut deep into the loess, making a belt of broken country. In most other places water falling within less than a mile of the bluffs flows eastward and finally into the Amite River.

The principal tributaries of the Amite River are the Comite River, draining the northern central part of the area; Big and Little Sandy creeks, draining a part of the northeast corner, and Wards and Dawson creeks, draining the southwest. All these streams, but more especially their smaller tributaries, are very sluggish, and either take their rise in flat, swampy areas or meander broadly through belts of swampy country. Only the larger ones have eroded any channels to speak of, and the majority have cut their beds only a few feet below the general level of the country; hence there exists over the parish a condition of sluggish natural drainage. The fall is so gradual that in times of heavy precipitation, such as occurs in winter and early spring, the streams are swollen far beyond their normal capacity, and large areas may be under water for a week or longer and remain too wet for cultivation for long periods. The smaller streams dry up during summer.

East Baton Rouge Parish lies entirely within the Coastal Plain. Formations belonging to the Lafayette, Port Hudson, and other Coastal Plain groups probably underlie most of the area, but only comparatively recent deposits—viz, the Mississippi alluvium and the loess or bluff formation of Pleistocene age—are exposed in sufficient areas to influence the soils. The alluvium covers only a comparatively small proportion of the area, but the most productive soils are found in this section. The loess covers the entire uplands section of the parish. It is from 10 to 20 feet thick near the river, but becomes thinner away from it. As to its exact method of deposition, opinions differ.

SOILS.

The soils found in East Baton Rouge Parish have been classified into six types, exclusive of Meadow, and may be divided into two groups—the alluvial and the upland. Excepting Meadow, which possesses a variable character, the upland soils are all derived directly from the loess and contain a high percentage of silt. The soils of the Mississippi bottoms, however, vary from sandy loams to the heaviest of clays.

The following table shows the area of the several types:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Memphis silt loam	219,200	75.9	Yazoo sandy loam	1,536	0.6
Sharkey clay	18,432	6.4	Yazoo loam	1,472	.5
Meadow	17,408	6.0	Total	288,512	
Marshall silt loam	16,640	5.8			
Yazoo clay	13,824	4.8			

MEMPHIS SILT LOAM.

The Memphis silt loam is an incoherent friable silt loam, of light-brown, yellow, or gray color, with an average depth of about 10 inches. The soil, which possesses a little more plasticity than a very fine, sandy loam, rests upon a claylike silt loam, which is usually somewhat stiff and plastic, but yet is made up largely of silt particles. The color of the subsoil varies from a light yellow or mottled yellow and gray to a chocolate brown, this variation being probably due to the amount of oxidation of the iron salts which it contains.

The Memphis silt loam is by far the most widely distributed soil type found in the area, covering in all about 342 square miles. It occurs in every part of the uplands, and its topographic features are those of this entire division of the area. Though very uniform in mechanical characteristics, there are differences of color and structure which follow topography and drainage. Along the bluffs, where the land is more rolling, and consequently better drained, the soil is of a deeper brownish color, with a dark-reddish or chocolate-colored subsoil. This phase, except where erosion has worked serious injury, is more productive than the light-yellow or gray soil that occupies the flatter areas. Where natural drainage is inadequate, as it is over the larger part of the parish, the lighter shades prevail, and in the semiswampy places the soil may be almost white, with a pale-yellow or light-mottled subsoil. The presence of large quantities of iron concretions in soil and subsoil indicate a low degree of oxidation consequent upon poor soil drainage and lack of aeration. These wet places, when cleared, require a year or two of cultivation and drainage before good crops can be grown upon them. Over considerable areas of the Memphis silt loam a condition of swampiness prevails. These areas have been outlined upon the accompanying soil map and their location indicated by the swamp symbol. Such areas are always wooded, usually covered with palmetto, and their only present value to the farmer consists in pasturage. They occupy flat country bordering streams or bayous or the lands at the headwaters of smaller streams. The soil in such areas does not differ in mechanical composition from the cultivated land of the type. Here, as before stated, the lack of drainage and aeration is apparent in the light-gray or whitish color of the soil, and it is very common to find a more or less perfectly cemented hardpan at a depth of 20 to 36 inches. This will be further discussed under "Drainage."

The texture of this soil makes it valuable for a wide variety of crops. With reasonable care it can be kept in a good, mellow tilth, as it does not bake nor clod as a clay soil does, and at the same time it is firm and compact enough not to be leachy and susceptible to drought, while only limited areas in East Baton Rouge Parish are rolling enough to be subject to washing. It is well adapted to grass, cotton, corn, sugar cane, and vegetables of all kinds. Small grains, such as wheat, barley, and oats have been grown with marked success in more northern climates, and it is probable that these crops might be added to the present rather limited number produced in the parish.

Cotton, corn, and sugar cane, with a few vegetables for home use, are practically all the crops now grown upon the Memphis silt loam.

Sugar cane does fairly well, averaging about 20 tons per acre, and in favorable seasons more. The yield is not so heavy as on some other soils, but the cane is richer in sugar than that grown upon the bottoms. There are no sugar houses near at hand, and the fact that the crop must be hauled or shipped by rail to refineries some distance away is very discouraging. Cotton is by far the most important crop, yielding in good seasons about three-fourths bale per acre. Corn returns from 15 to 25 bushels. Lespedeza is highly prized for pasturage or hay. It yields about 1 ton per acre, and in addition is a valuable fertilizer. Cowpeas are occasionally sown in the corn for forage, and this practice is to be commended. Crab grass grows spontaneously and makes a good hay, yielding from 1 to 2 tons per acre.

The Memphis silt loam should be an excellent soil for stock raising. Potatoes, strawberries, and other vegetables and truck crops could probably be grown with profit along the line of the railroad.

The following table shows the average results of mechanical analyses of Memphis silt loam as found in East Baton Rouge Parish:

Mechanical analyses of Memphis silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12654, 12650	Soil	0.2	1.4	0.4	0.6	2.9	78.1	15.9
12651, 12655	Subsoil	.1	.6	.4	.9	1.9	74.3	21.3

MARSHALL SILT LOAM.

The Marshall silt loam is a black or dark-brown soil found in the uplands. A typical section shows a dark-brown or black silt loam from a foot to 18 inches in depth, underlain by a sticky silty clay of a drab or mottled-yellow color. Just below the dark surface soil a stratum of lime concretions is generally found. This is often from 9 to 12 inches in thickness, but only in a few cases was it found to form a true crust or hardpan, the usual occurrence being more in the form of small segregated nodules. It is not uncommon to find the surface 5 or 6 inches of soil a dark-brown or brown friable silty loam, while immediately underlying this to a depth of 15 or 18 inches occurs a stiff, plastic, dark-colored soil, much like a true clay. Farmers speak of this as the "slick layer" when it is turned up by the plow.

While formed from precisely the same material as the Memphis silt loam, this type is much more difficult to work than the latter, and shows considerable tendency to clod and puddle if handled when too wet and to bake if left unstirred in the field for a long time.

The Marshall silt loam occurs only in the upland portion of East

Baton Rouge Parish. While a few scattering areas of no great extent are found in various sections, the largest body occurs a few miles east and northeast of Baton Rouge. It generally occupies low, flat areas, and a good deal of it is in a swampy condition and unfit for cultivation at present. To a great extent it coincides with the sags and broad depressions, but is sometimes continuous over a low rise. However, practically all of it requires artificial drainage for the best results, and most of it for any cultivation whatever.

The Marshall silt loam, like the Memphis silt loam, is formed from the loess. Through the influence of poor drainage and the consequent rank character of vegetation a large amount of organic matter has become incorporated in the soil. The larger organic matter content and the presence of the lime nodules, with accompanying modifications, are the chief differences between this soil and the Memphis silt loam.

According to the testimony of those who have farmed it, the crop values and special adaptations of the Marshall silt loam vary somewhat with the seasons. In favorable years cotton yields from 1 bale to 1¼ bales per acre, yet in a very wet or a very dry season much smaller yields are secured. This crop also rusts badly when heavy rains are followed by hot, dry weather. It is probable, if the land were artificially drained, that this difficulty could be largely overcome by stirring the surface with a cultivator before it had baked or hardened. Corn and sugar cane both do well, the latter being better adapted to this type than to the other upland soil. Corn averages 10 to 25 bushels. Crab grass is considered the best grass for hay. Clover does not thrive, but Bermuda grass makes excellent pasturage.

The following table shows the average results of mechanical analyses of the Marshall silt loam of East Baton Rouge Parish:

Mechanical analyses of Marshall silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12644, 12646	Soil	Tr.	0.4	0.1	1.2	4.2	73.5	20.2
12645, 12647	Subsoil	0.1	.5	.2	.7	3.3	80.3	14.7

YAZOO CLAY.

The soil of the Yazoo clay, to a depth of from 5 to 10 inches, consists of a brown clay or clay loam. This is underlain by a plastic drab or mottled yellow and gray clay to a depth of 3 feet or more. Occasionally sand is struck within 3 feet, and in other places a layer of fine sand and silt a few inches thick is found, the material immediately above and below this being clay. The soil carries considerable organic matter and has the property of granulating or falling to pieces when cultivated or exposed to the air. If left unstirred for some time and allowed to pack and afterwards to dry, the surface becomes dissected with a series of cracks, often sufficiently wide and deep to put one's hand in for some little distance. When in the proper condition of moisture this soil is not looked upon as particularly difficult to cultivate, but if handled when too wet it becomes very hard on drying, and when it has become very dry, as sometimes happens in the autumn months, it is almost impossible to plow it at all.

The Yazoo clay is the soil type of greatest extent, and by far the most important agriculturally, in the Mississippi bottoms. It is found in one unbroken area south and southeast of Baton Rouge. The surface is generally quite flat, with few natural drainage channels, and this, together with its close structure, results in imperfect drainage; hence over much of the area it has been found necessary to construct open ditches a few rods apart to carry the surplus water into the bayous. No tile drains are at present used. It is claimed that tiles laid in this soil are very hard to keep clear of silt, but it is probable that this could be remedied by very careful laying. While at the present time and at the present prices of land it might be questioned whether it would be profitable to use tile, since they would need to be laid very close together, yet as the land becomes more valuable the space required for open ditches will be needed for cultivation, and underground drains will then be economical. Moreover, the open ditches require to be cleaned out frequently, as they furnish a harboring place for weeds. However, the ditches used at present do the work fairly well, and except in very wet seasons farmers usually have ample time to prepare the soil for crops.

The materials of which the Yazoo clay is composed are the clay and fine particles left in quiet water by the river during seasons of overflow, but the type does not represent the finest particles, which make up the Sharkey clay. It is naturally a very productive soil, undoubtedly the most productive in the parish, and has been cultivated for a great many years with scarcely any diminution in the yields. Practically every foot not in ditches or roads is under cultivation, and it is considered the most valuable land in this section. Cotton is the chief crop and easily averages 1 bale per acre, while yields of 1½ to 2 bales or more are not uncommon. Sugar cane is the crop next in importance and yields 25 to 35 tons per acre. While this crop is relatively less important in East Baton Rouge Parish than in other parts of Louisiana, it is worthy of note that the Yazoo clay is one of the great sugar-cane soils of the State. A small acreage has been devoted to rice, which yields from 10 to 15 sacks (the weight of a sack ranges from 140 to 200 pounds) per acre. Of the minor crops are corn, which is probably next to sugar cane in acreage; alfalfa, which is cut four to six times in a season, yielding from 1 to 1½ tons per cutting; and cowpeas.

Yazoo clay is well adapted to the crops grown, especially cotton and sugar cane. However, the growing of one crop continuously is apt to injure even this productive soil, and some legume, such as cowpeas, should be planted at least once in three or four years. Grasses would probably do well, and onions and other crops requiring a heavy, rich soil might prove profitable. This land is held at from $20 to $60 an acre.

The following table shows the average results of mechanical analyses of the Yazoo clay as found in East Baton Rouge Parish:

Mechanical analyses of Yazoo clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12666, 12664......	Soil........	0.0	0.3	0.2	1.5	6.8	43.0	48.1
12667, 12665......	Subsoil.....	.0	.2	.2	1.2	4.4	54.6	39.1

YAZOO LOAM.

The soil of the Yazoo loam is a brown loam from 6 to 12 inches in depth, in which there is a considerable proportion of very fine sand and a preponderance of silt, but very little of the coarser grades of sand. The subsoil is usually a drab or yellowish clay loam, which often grades into a heavy clay at from 20 to 30 inches. The soil is loose and easily cultivated when in proper condition of moisture and does not become very sticky when wet nor form hard clods or bake when dry.

The Yazoo loam is found in narrow bands along the Mississippi River and in somewhat elevated portions of the bottoms south and southeast of Baton Rouge. In East Baton Rouge Parish the areas are small and those found along the streams are highest along the stream banks. Areas at a distance from the streams have their centers a few feet above the surrounding soil. The drainage of this soil is undoubtedly better than that of the Yazoo clay, from which the Yazoo loam is usually easily distinguished by its lighter color. Some of the areas away from the rivers are poorly drained, and in these water often stands for some time during heavy rains.

The material of the Yazoo loam is composed of particles slightly coarser than those of the Yazoo clay. These have been laid down by the waters of the Mississippi River during high water, and occur where the current was relatively swift. While perhaps not as strong a soil as the latter, the Yazoo loam is looked upon as a productive type and by some is preferred, as it is more easily worked. As a rule it is held at about the same price.

Cotton is the chief crop at present and yields from three-fourths to 1 bale per acre. Corn, where grown, yields from 20 to 35 bushels per acre, and other crops in proportion. The Yazoo loam is well adapted to these crops and to sugar cane, rice, etc., but will not stand such exhaustive methods as the Yazoo clay, and more attention needs to be paid to the incorporation of organic matter in the soil and to the use of leguminous crops. Alfalfa grows very well. The Yazoo loam is also a fair truck soil, but is not so early as the Yazoo sandy loam.

The following table shows the results of mechanical analyses of the Yazoo loam as found in East Baton Rouge Parish:

Mechanical analyses of Yazoo loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12660	Soil	0.0	0.1	0.1	0.7	19.3	62.9	16.8
12661	Subsoil	.0	.1	.1	.5	6.6	61.9	30.5

YAZOO SANDY LOAM.

The Yazoo sandy loam is a light-brown or yellow, fine to very fine, sandy loam, generally quite incoherent, and about 12 inches in depth. The subsoil has much the same texture as the soil, but contains less organic matter, and is often little more than very fine yellow sand. There is considerable silt mixed with soil and subsoil, but practically no clay, except where the underlying stratum comes near to the surface, where the sandy layer thins out toward adjacent areas of loam or clay.

The Yazoo sandy loam is found only in the Mississippi bottoms, where it occurs as low ridges along the banks of the river. It represents the coarsest particles deposited by that stream from its swiftest overflow waters in times of floods. Only limited areas occur in East Baton Rouge Parish, amounting in all to about 1,536 acres. A small strip occurs along the river bank south of Port Hudson, where it forms a natural levee for that undiked portion of the bottoms. Other small areas are found south and southeast of Baton Rouge.

On account of its texture and slightly elevated position, the Yazoo sandy loam is the best-drained soil of the Mississippi bottoms. For this reason it is an early soil and well adapted to the production of market-garden crops. At present it is planted to the crops most extensively grown in the bottoms, viz, cotton, corn, and sugar cane. All of these give fair average yields, though where the soil becomes very light and loose in texture it produces less than the typical soil, and the crops are much more subject to injury by drought.

The following table shows the results of mechanical analyses of samples of the Yazoo sandy loam as found in East Baton Rouge Parish:

Mechanical analyses of Yazoo sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12662	Soil	0.0	0.1	0.1	7.3	49.7	33.8	9.0
12663	Subsoil	.0	.1	.1	1.9	37.7	50.3	9.8

MEADOW.

In this area the term "Meadow" includes all those narrow strips of overflow land lying along the main stream courses. The soil material varies from an incoherent silt from 5 to 6 feet in depth to an almost pure wash sand. As a rule the more silty material is confined to the smaller streams and to the territory along the larger ones most subject to wash from the uplands. Near the Comite River it is an almost pure white sand.

The surface of the Meadow is broken by gullies and sloughs, which mark former courses of the streams. Generally these are filled with water most of the year, and if of any size are covered with cypress trees, while the surrounding soil is covered with gum, bay, oak, and other trees. Practically all of the Meadow is wooded, the only cultivated spots being along the Amite River and where the roads cross the streams in other places. The greater part of the type is found along the Amite and Comite rivers, and only narrow strips are seen along other streams. It is formed from sediment deposited by the streams during seasons of overflow, and owes its variable character to the varying swiftness of the currents that have deposited it. The larger streams have a stronger current and carry considerable sand, while the smaller ones are laden with silty particles derived from the uplands.

The surface is only fairly level, being broken by the sloughs above mentioned, and except in times of high water the soil is fairly well drained. It is, however, always subject to sudden overflow during heavy rains, and the risk taken in growing crops is great; hence very little of the type is under cultivation. It is considered a good soil, but farmers say poor spots are often left in the fields after overflow, caused by the washing away of the soil or the depositing of sand. The heavier portions, if cleared, should prove a good soil for cotton, corn, or sugar cane.

In the present condition the Meadow is of little value except as pasture for cattle, which are sometimes drowned by sudden rises in spring, especially in the broader areas.

SHARKEY CLAY.

The Sharkey clay is the heaviest type of soil found in this area. The soil proper is generally composed of from 4 to 8 inches of dark-brown or black clay, with considerable partly decomposed vegetable matter mixed with it. This is underlain by an exceedingly heavy drab or mottled clay. In the few instances where the soil was found under cultivation the subsoil had been mixed with the soil, producing a deeper dark-brown heavy clay that is very intractable, baking and sun-cracking badly. In wet weather the Sharkey clay becomes so sticky that masses of it adhere to the wheels of vehicles until it is next to impossible to drive across it. When it has become dry and packed, roads upon it become hard and glassy, resembling asphalt.

The Sharkey clay is found in the lowest parts of the Mississippi bottoms, where the water stands longest at times of inundation. Such areas are usually found along the bluffs. One large area is found in the undiked portion of the bottoms north of Baton Rouge, while other areas are found south and southeast of that city.

The surface of the Sharkey clay is level and the natural drainage is poor. Almost the entire body is in a condition of swamp, water standing on the surface a great part of the year. There are few drainage channels, and these almost on the surface, and the soil is naturally so compact and impervious that little water finds its way into the subdrainage, and hence a great deal of it must escape by evaporation. The type is covered by a dense growth of cypress, palmetto, gums, and other water-loving trees and shrubs, with some valuable timber.

The Sharkey clay is an alluvial soil, and the particles of which it is composed are the finest carried by the waters of the Mississippi. These have been deposited during seasons of overflow in places where there was practically no movement and the water remained imponded for long periods.

The Sharkey clay is everywhere recognized as a strong, fertile soil, producing large yields of cotton, corn, and sugar cane.

Though stiff and intractable and requiring careful handling, it is nevertheless a valuable soil, and with proper drainage and wise cultural methods the tilth improves very materially. The reclamation of most of it, however, is a difficult engineering problem and would require the outlay of considerable capital. In its present condition this type has little value except for the pasturage afforded by the wild cane and undergrowth.

The average results of mechanical analyses of samples of the Sharkey clay are shown in the following table:

Mechanical analyses of Sharkey clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12656, 12658.......	Soil	0.0	0.2	0.2	1.8	1.8	44.8	51.1
12657, 12659.......	Subsoil.....	.0	.3	.3	1.8	1.8	42.1	53.5

DRAINAGE

It will have been noted in the preceding pages that scarcely any soil type has been described that is not in need of artificial drainage to bring it up to its normal producing capacity. The Memphis silt loam, the Marshall silt loam, the Yazoo clay, and the Sharkey clay, which together cover nearly the entire area of the parish, are all types in which large sections need artificial drainage. A reference to the soil map will show that there are large areas in all parts of the parish that are in a condition of semiswampiness and therefore of little or no agricultural value. It is probable that all such areas in the uplands could be reclaimed quite easily. By deepening and straightening some of the smaller streams and by building large community ditches, a sufficient outlet might be obtained to care for the normal run-off of the low, flat sections. Such work would necessarily have to be done on a large scale and either under the direction of parish officers or of a number of landowners in cooperation. Under existing conditions the natural drainage is insufficient, the sluggish creeks and bayous are unable to carry off surplus water in times of heavy rainfall, and wide areas are often flooded for a week or more, while pools of standing water remain on the surface for considerable periods. During these times water is found within a few inches of the surface over large areas of cultivated lands. Though this condition seldom occurs while crops are growing, the effect is injurious to the land and yields are reduced. There is also often more or less delay in putting in crops from this cause. Increasing the effectiveness of the natural drainage channels would not only reclaim much land now practically worthless, but would also increase the productive capacity of much now under cultivation.

Most of the areas indicated upon the map as swampy are characterized by a soil in which a low degree of decomposition and poor soil aeration are evident. A hardpan of partly cemented clay is found at a depth of from 2 to 4 feet. This stratum is, as a rule, not so firm but that it can be penetrated by the soil auger, yet it is practically impervious to water. Areas were observed where water had been standing on the surface for several days, yet this layer was perfectly dry. Experience in other places has proved that thorough drainage will in time tend to break up this layer. A drainage system would probably have to be in operation a few years before the best results could be obtained from the land.

Some ditching has been done by individuals, always with excellent results, but on the whole the farming population of this section have not realized the extent to which good drainage would improve the land. What has been done is usually with an idea of carrying off surface water rather than to remove the excess of soil water. For best results with ordinary crops, standing water should never be within less than 2 to 3 feet of the surface. As far as could be learned, no tile or other underground drains for purely agricultural purposes exist in this section. Until the larger outlets are improved underdrainage could not be made fully effective, and yet there are many instances where an individual farmer could, by the construction of a few ditches and tile drains, so improve the value of his land as to more than pay the cost of such operations in a short time.

Reclamation of the swampy areas in the Mississippi bottoms is a problem of more magnitude. It would require expensive diking in most cases, but the value of the cultivable lands thus reclaimed would be so great that outlays of large sums of money would be justified.

AGRICULTURAL CONDITIONS.

As cotton is almost the sole reliance of the farmers of East Baton Rouge Parish, the prosperity of the agricultural class depends to a great extent upon the yield and price of that crop. Under the system of purchasing all needed supplies and giving liens against the prospective crop, good farmers estimate that cotton must bring 7 to 8 cents per pound in order that the planter may meet his ordinary obligations. As the price of cotton has varied greatly in recent years, so there have been great variations in the money returns secured from plantations. On the whole, while there are planters who, on account of superior business ability and good farming, are making money, the majority are doing little more than keeping even.

Something more than one-third of the total area of East Baton Rouge Parish is actually under cultivation. The remainder is in forests and swamps. The greater part of the cultivated land is in the western half, along the Yazoo and Mississippi Valley Railroad and the Mississippi River. As distance from the railroads and navigable streams increases, the farms become less numerous, until at the farthest points, strips along the public roads and small clearings in the woods are the only cultivated land seen. The average value per acre of lands over the entire area is about $7 an acre, but the selling price ranges from $5 an acre for uncleared lands to $50 or $60 for improved cultivated land near towns in the uplands and slightly more than that in the bottoms. Most of the cultivated land in the uplands can be had for from $20 to $30 an acre. As this land rents at from $4 to $5 an acre, it is readily seen that at present prices land in this area should return a good interest on the investment.

Only about twenty-seven out of every hundred farms in this parish are operated directly by the owners. The remainder are rented under one or another of three systems—for cash, for so much lint cotton, or for a certain proportion of the crop. The cash rent of land is usually about $5 an acre. In this case the landlord takes a first lien on the cotton crop for his money, and the merchant who furnishes the tenant his supplies has a second lien. When rented for a proportion of lint cotton, the landlord receives from 500 to 600 pounds for 10 to 12 acres of land, and the tenant furnishes teams, fertilizers, etc., and pays ginning expenses, the landlord furnishing nothing but the land. Under the third system, the landowner provides teams, feed, implements, etc., and pays for one-half the fertilizers and ginning expenses, and receives from one-fourth to one-half the crop. Most of the tenants are negroes, though there are a few whites. A few negroes own their land. Some of the larger plantations are looked after by managers, who receive a salary or fixed proportion of the crop. These may lease the land in small parcels to tenants or cultivate it by hired labor. Most of the men who live on the farms lease the greater part of their land and exercise almost as much supervision over the tenants as over hired labor, so that much more of the land is managed by the owners than would appear upon the face of the transactions.

The size of farms varies from 15 to 20 up to several thousand acres. According to the census of 1900, the average-sized farm is 80 acres,[a] of which 20 to 30 acres would be under cultivation. Tenants usually work from 15 to 25 acres of cultivated land. A considerable proportion of the land in the parish is owned in tracts of 1,000 to 2,000 acres or larger. Frequently on the same plantation a part may be rented for cash, a part on shares, and the remainder worked by hired labor. As a rule, land in the Mississippi bottoms is held in larger tracts than in the uplands. The average value of the farms is about $1,400, of which $700 represents the value of the land, $250 the buildings, $150 the implements, and $250 to $300 the live stock.

Farm labor is almost exclusively colored. Field hands receive from $10 to $15 a month and board during the season. Cotton pickers usually receive 50 cents per hundred pounds of seed cotton, but at times as high as 75 cents has been paid. All the members of the family work at cotton picking. In East Baton Rouge Parish negro labor is regarded as fairly efficient, especially where cotton is the crop. Sometimes there is trouble in securing enough hands. As a rule, the negroes prefer to rent land on the share system when cotton is high, but to work for wages when it is lower in price. However, it is much the same to the landowner, as almost as much supervision is given in one case as in the other.

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[a] According to the census classification each parcel farmed by a tenant was counted a "farm."

Cotton is the principal product of East Baton Rouge Parish. Probably more than one-half of the entire area of cultivated land is planted to this crop every year. After cotton, corn is the important crop in point of acreage, occupying about one-fourth of the cultivated land. This does not produce enough corn to supply the local demand, and many farmers find it necessary to buy. The yield is somewhat low—15 to 25 bushels per acre—and the quality generally poor. Some farmers buy northern corn for seed, and this is said to be earlier and better for the first year, but afterwards becomes very similar to that grown here, probably largely because of mixture with the native corn. Corn is usually planted in rows 4 or 5 feet apart, although the land is productive enough to stand closer planting. Aside from climatic influences nearly all soils in East Baton Rouge Parish are good corn soils, and it would seem that it should be practicable to increase the yield by closer planting, deeper plowing, more careful cultivation, manuring, and more careful selection of seed, so as in time to produce a better variety adapted to the climate.

Sugar cane is the third most important crop, some 7 or 8 square miles being devoted to it, chiefly in the Mississippi bottoms in the vicinity of Gardere Station and Burtville. The yield varies from 25 to 35 tons per acre in the bottoms and from 20 to 25 tons per acre in the uplands. Planters usually obtain from $3 to $3.50 a ton for their cane, which makes the acre value of this crop very high; but as there is a great deal of labor required, and seed cane costs from $10 to $12 an acre, the profits are not so great as would appear. The fields are left in cane two years, after which it is considered the best plan to plant the land in corn, in which cowpeas are sown.

The rotation best suited to the soils and conditions in the uplands, in the opinion of the best farmers, is cotton two years, followed by corn in which cowpeas are sown at the last plowing, the latter being cut for hay or pastured, and followed the next year by cotton. This is a good rotation and the practice is to be commended, but as a general rule the cowpeas are left out. Of the minor crops Japan clover is considered the best forage crop. It is not grown in any regular rotation, but in small fields, and generally yields from 1½ to 2 tons per acre. It is said to do well on poor land and to be very beneficial to the soil. The farmers would probably find it to their advantage to grow it more extensively. Bermuda grass and crab grass are also grown for hay and pasture.

More or less live stock, consisting of cattle, hogs, sheep, and a few goats, is kept within the parish. As a rule these run wild during the winter and pick up what they can from the woods and canebrakes. Frequently a considerable number are lost by drowning or exposure. Cattle are turned on pasture in spring and fattened to some extent before selling. As a rule the native cattle and other live stock would be considered rather poor, though there are a few farms within the area on which improved animals are kept. As the soil grows such excellent grass and the season during which cattle may be kept on pasture is so long, it would seem that the production of live stock should prove a profitable business. For best results, however, a better grade of animals than the native would be required. The manure would also prove an item of profit if properly husbanded and applied to the fields.

Most farmers produce Irish and sweet potatoes and other vegetables for their own use, and a small area around Baton Rouge is devoted to truck gardening. A few hundred acres in the Mississippi bottoms are used to grow rice.

As has been stated elsewhere, one of the great needs of the farms in East Baton Rouge Parish is drainage—not only surface drainage, and the reclamation of swampy areas, but underground drainage, which would keep the soil from being soaked with water for long periods and also permit soil aeration. This, the practice of deeper plowing, the use of stable manure and green manuring leguminous crops, and a substitution of some other money crop on a part of the cotton acreage are some of the changes which would seem necessary before the best results can be secured from agriculture in this area.

The Yazoo and Mississippi Valley Railroad, running near the western border of the area, is the only railroad at present (1905) in active operation. The Shreveport and Red River Valley Railway is completed north of Baton Rouge, leaving the parish near Port Hudson, and within a few years will probably be finished southeast, extending out from the parish in that direction near Hopevilla. The Mississippi River forms the western boundary of the area and provides cheap transportation for those living near, and through competition keeps down freight rates for those within reach. The Bayou Manchac is navigable up to a few miles beyond Hopevilla and provides transportation for the southeast corner of the parish. The Amite River is not navigable beyond the point of junction with the Manchac, hence a railroad is badly needed in the northeastern part of the parish. It is expected one will be built out from Zachary and another eastward from Baton Rouge in a few years, and these should prove of very great benefit to the farmers in these localities.

The parish has good dirt roads, but at present they are not kept in very good condition. The silt soils of the uplands make roads that are excellent when dry but very muddy when wet. Over much of the area, however, it is simply a question of grading and drainage in order to have fine roads nearly all the year. The parish has recently purchased a road-grading machine and the roads are being put into good condition as fast as possible. Some gravel is found in places along the Amite River, and this should prove very valuable in road construction and maintenance.

Ultimately almost all cotton, sugar, etc., sold in this parish reaches New Orleans, but these products and others are first delivered to merchants in Baton Rouge, Baker, Zachary, Port Hudson, Burtville, etc., who later ship to the first-named city. There is a cotton-seed oil mill and a sugar refinery at Baton Rouge and two sugar refineries near Burtville, which handle all of these products grown in the parish. Gins are found at convenient places throughout the area surveyed, but after ginning many farmers have to haul their cotton long distances to market, which greatly reduces their profits.

SOIL SURVEY OF HOUSTON COUNTY, TEXAS.

By WILLIAM T. CARTER, Jr., and A. E. KOCHER.

LOCATION AND BOUNDARIES OF THE AREA.

Houston County is situated in the central-eastern part of Texas. It lies about 140 miles north of the Gulf of Mexico and about 80 miles west of the Louisiana State line. It consists of a land area of 762,752 acres, or about 1,192 square miles. The county is irregular in outline, the Neches River forming the eastern and the Trinity River its western boundary. On the north lies Anderson County; on the east, Cherokee and Angelina counties; on the south, Trinity and Walker counties, and on the west, Madison and Leon counties.

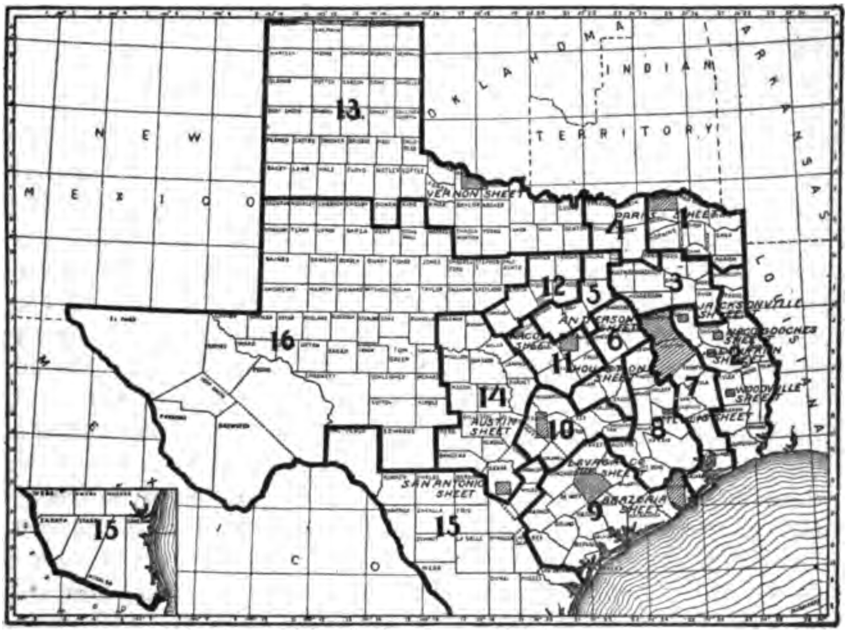

FIG. 22.—Sketch map showing location of the Houston County area, Texas.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Houston County is one of the oldest of the east Texas counties. It was formed from a part of Nacogdoches County in 1839, but in 1846 its area was reduced to form Anderson County. Probably the first settlement in the county was at Crockett about 1835. In the early history of the State all travel from San Antonio to Nacogdoches passed through the county over the old San Antonio trail. The place where Crockett now stands became a favorite camping place with the travelers, and from a camping place it gradually grew into a town as the country round it became settled. The first settlers came from the older southern States, but in those days travel was laborious, immigration scant, and settlement extremely slow. However, with the advent of railroads and better means of transportation, the settlement of the county steadily advanced, until at present the population numbers about 30,000.

Land was easily obtained, liberal allowances of land being offered by the State to settlers. An unmarried man was allowed to homestead one-third of a league, while a married man could homestead a league and a labore.[a] The early settlers lived in a very primitive manner, there being no access to markets or cities except by long, tedious journeys over wagon roads. They paid little attention to agriculture, growing only the small supply of corn and vegetables necessary for the use of themselves and what little stock they possessed. After settlement of the country had begun, however, it was found that it was possible to secure a good yield of cotton on the sandy soils of the uplands and on the creek bottoms, and since that time cotton has been the principal money crop of the county. Corn, sugar cane, and small quantities of fruits and vegetables have been the other leading crops.

Before there were any railroads in the county the nearest markets were Houston, Tex., and Shreveport, La., Houston being 100 miles distant, and Shreveport farther. Cotton and live stock were at first the only products sent from the county. The cotton was hauled and the cattle were driven in small droves to these two markets. From these places the other markets of the world were easily reached by rail and water. This method of marketing was tedious and costly, but prices were good and fair profits were made. Although the county was heavily wooded, it was found that cattle and hogs could be easily raised at small cost, and for many years the production of this kind of stock has steadily increased until at present Houston County probably sends to market more live stock than any other east Texas county.

In 1874 the International and Great Northern Railroad was built through the county, bringing it in closer touch with the larger markets, and since that event the agricultural conditions in the county have greatly improved, settlement has been more rapid, and land, especially along this road, has increased in value. That part of the county, however, which is not near the railroads is still thinly settled, and agricultural development is slower. In the eastern part of the county great forests of pine still exist, and the lumbering interests constitute an important industry. During the last few years the people living near the International and Great Northern Railroad, in the central part of the county, and along the Eastern Texas Railroad in the eastern part of the county have awakened to the possibilities of truck farming and fruit growing, and have been setting out orchards and producing early truck for the large markets. Although these interests are still in an early stage of development, the experimental stage has been passed, and the results seem to warrant the belief that they will become permanent and important factors in the agriculture of the county.

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[a] A league is 4,500 acres, and a labore 177 acres.

CLIMATE.

The climate of Houston County is temperate, and is well suited to the growing of a large variety of agricultural products. The growing season is long, and many crops may be grown during the greater part of the year. The winters, as a rule, are mild, although occasional freezes occur. The coldest months of the year are January and February. Periods of cold weather occur at irregular intervals during the winter, being caused by the cold north winds which sweep over the greater part of the State. These cold winds are known as "northers," and come up very suddenly, causing a rapid lowering of the temperature. However, these periods of cold seldom last more than three or four days. These "northers" are the outward limits of cold waves in the north and northwest. A light snow sometimes falls, but owing to the mildness of the climate, it soon melts. The summers are long, but the heat is seldom excessive, owing to the modifying influence of the Gulf.

The rainfall of Houston County is usually ample for all crops and is well distributed throughout the growing season. Excessive rainfall or long periods of drought are exceptional. Disastrous winds or hailstorms seldom occur.

There is no Weather Bureau station in Houston County. The nearest stations are located at Palestine, in Anderson County, and at Huntsville, in Walker County. Palestine is about 40 miles north of Crockett, and Huntsville is about 50 miles southwest of Crockett. The climatological data obtained at Palestine probably very fairly represents the climatic conditions in the northern part of Houston County, while the records at Huntsville are representative of the climate in the southwestern part of the county.

The following tables show the normal and annual temperature and precipitation, and the dates of first and last killing frosts at Palestine and Huntsville:

Normal monthly and annual temperature and precipitation.

Month.	Palestine.		Huntsville.	
	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	Inches.	°F.	Inches.
January	49.8	4.31	50.1	4.78
February	51.0	3.51	51.8	3.17
March	57.6	3.96	59.6	3.55
April	66.7	4.62	67.9	4.10
May	71.3	5.84	74.9	3.90
June	78.2	4.25	80.9	5.14
July	81.5	2.59	83.4	3.25
August	80.4	2.68	82.8	3.46
September	75.7	3.25	77.4	3.23
October	66.5	3.22	69.0	3.10
November	56.2	4.45	....	4.23
December	51.4	3.81	....	3.58
Year	65.5	46.51	....	45.49

Dates of first and last killing frosts.

Year.	Palestine.		Huntsville.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1896	Mar. 20	Nov. 8	Mar. 20	Nov. 8
1897	Feb. 27	Nov. 2	Feb. 2	Nov. 18
1898	Mar. 24	Oct. 27	Mar. 5	Nov. 21
1899	Mar. 28	Nov. 8	Mar. 7	Dec. 29
1900	Apr. 12	Nov. 12	Mar. 17	Nov. 12
1901	Mar. 6	Dec. 9	....	....
1902	Mar. 5	Dec. 4	Feb. 16	Dec. 4
1903	Mar. 1	Nov. 18	Feb. 22	Nov. 18
Average	Mar. 16	Nov. 14	Mar. 1	Nov. 24

PHYSIOGRAPHY AND GEOLOGY.

Houston County lies within that part of the Coastal Plain of Texas known as the East Texas Timber Belt. In general its surface is gently rolling and sloping. The general slope of the county is to the south and east. In the northeastern and northwestern parts of the county the surface is broken and hilly, which is due to erosion having worked out a drainage system whose main outlets are much lower than the surrounding country. In the central part of the county the surface is gently rolling, and, on the whole, the drainage is good. In the southern part of the county the surface, while gently rolling, is more nearly level. This classification of the topography applies to the several portions of the county in a general way, but there are local exceptions.

Houston County has an extensive and intricate drainage system. The Trinity River, on the west, and its tributaries, and the Neches

River on the east and its tributaries make the county in general a well-drained region. The tributaries of these rivers extend from the borders of the county in toward the center, each having many smaller branches which reach into all parts of the county. A few areas, however, are very nearly level, and here drainage is quite poor, though it could be greatly improved artificially, either by open ditches or tile drains.

The largest of the tributaries of the Trinity River, in the western and southern parts of the county, are the North Elkhart, Big and Little Elkhart, Cane, Lost, Kellison, Negro, Tantabogue, and White Rock creeks and Hurricane Bayou. The principal tributaries of the Neches River, in the eastern and southeastern parts of the county, are the Cypress, San Pedro, Hickory, Silver, Camp, and Piney creeks and Cochino Bayou. In the northern part of the county the creeks and branches flow during the whole year, and that region is extremely well watered. In the southern part the creeks are usually sluggish, and in the summer the most of them are quite dry.

Along the rivers the bottoms in Houston County vary in width from one-fourth mile to several miles, while on the creeks the bottoms are from one-fourth to 1 mile in width. The beds of these streams lie from 5 to 20 feet below the surface of the bottoms, but during extended periods of wet weather they are all inundated, sometimes for several days, to a depth of several feet.

In the northeastern and northwestern parts of the county, for several miles south of the Anderson County line, the creek bottoms lie from 50 to 150 feet below the surrounding rolling uplands, and the slopes are sometimes long and gentle and again precipitous and stony. Going southward through the county the topography gradually changes, the stream bottoms are nearer the surface of the surrounding country, and the slopes are more gentle. In the extreme southern part the streams are generally but a few feet below the upland.

A feature of the topography of the southern part of the county is the existence of several small prairies, whose total area does not exceed 50 square miles. These prairies are East, Tyler, Nevill's, and Mustang. They have a gently rolling surface and strongly resemble each other in soil and general structure. At one time they were probably lake beds. Throughout the central part of the county the topography inclines to be somewhat hilly, several of the higher points being locally known as mountains. Of these the most pronounced is Cooks Mountain, which is near Crockett, and which rises about 100 feet above Crockett.

According to Kennedy,[a] the geological formations of Houston County consist of deposits of the Recent, Quaternary, and Tertiary periods. The Recent deposits occupy a considerable extent along the Trinity and Neches rivers, and along the bottom lands forming the flood plains of the larger creeks. The thickness of these deposits probably will not exceed 20 or 30 feet. The remains found in these beds are usually stumps, branches, and leaves of vegetation now growing along the banks of the streams.

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[a] Third Annual Report of the Geological Survey of Texas, 1891.

The Quaternary deposits occupy the greater proportion of the more elevated areas of the northern part of the county and some areas of the southern part. These deposits are represented by yellow, brown, and gray sands, red sandstones, gravels and conglomerate iron ores in the northern portion; siliceous pebbles, fossil woods, and prairie lands in the southern portion.

The Miocene deposits are represented by gray sands and sandy clays, shaly clays, blue sandy clays, and lignite. These deposits occupy the greater part of the southern and eastern parts of the county. A mine of lignite is operated near Lovelady, and a good local market is found for the entire output.

The Eocene deposits occupy the greater part of the northern region of the county, extending from river to river across the county, and are covered throughout their greater extent by deposits of Quaternary sands and gravels and occasionally by heavy deposits of conglomerate iron ore. The Eocene is composed of glauconitic sandstones, laminated iron ore, fossiliferous sands, green marly clay, and dark clay with lime concretions; also by gray plastic clay, sand, and fossiliferous greensand marls.

Adams[a] classes all the upland part of Houston County as the Eocene Tertiary. That part lying north of a line extending through the county in a northeast and southwest direction and passing through Crockett he correlates with the Lower Claiborne stage or Marine beds. South of this line is found the Jackson stage or Yegua clay; while in the extreme southeastern part of the county are found the Fayette sands.

Many borings have been made in the county in the search for oil, and though none of these has been successful a boring near Lovelady gave a fine flow of artesian water.

SOILS.

Houston County is a region of varied soil materials, and includes in its area of 1,192 square miles sixteen distinct types besides Meadow. The texture of these soils ranges from heavy clay to light porous sand, and only the silt loam class is not represented. Members of at least four prominent Coastal Plain series are found. The following table gives the name and extent of each of the types mapped:

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[a] Bulletin 184, U. S. Geological Survey, 1901.

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Lufkin fine sand	184,384	24.2	Yazoo loam	25,280	3.3
Norfolk fine sandy loam	145,408	19.1	Orangeburg clay	7,488	.9
Norfolk fine sand	79,872	10.5	Crockett clay loam	5,812	.7
Lufkin clay	59,200	7.7	Norfolk sand	4,544	.5
Orangeburg fine sandy loam	57,088	7.5	Houston black clay	3,200	.5
Meadow	52,864	6.9	Sharkey clay	3,008	.5
Susquehanna clay	50,816	6.6	Yazoo sandy loam	2,688	.4
Wabash clay	48,768	6.4	Orangeburg fine sand	704	.1
Susquehanna fine sandy loam	32,128	4.2	Total	762,752	

NORFOLK SAND.

The Norfolk sand consists of about 12 inches of sand, composed of 50 per cent of the medium and coarse grades, and 30 per cent fine sand. The color of the first few inches is gray, but it gradually changes into yellow with depth. The subsoil from 12 to 36 inches is a yellow sand, coarse to medium in texture, and this material sometimes extends to a depth of 40 feet. The Norfolk sand is a very loose and incoherent soil, but where newly cleared it often contains enough organic matter to give it a somewhat loamy texture. By exhaustive cultivation this organic matter is soon dissipated.

There are only a few small areas of this type in Houston County. The largest bodies are located in the vicinity of Grapeland and in the northern part of the county. They are usually surrounded by areas of the Norfolk fine sand, which occupies a lower elevation. The surface is very gently rolling, and the surface drainage is good, while the texture of the subsoil admits of a rapid passage downward of any excess of soil water. The outward limits of this soil are often marked with springs which form stream heads.

The Norfolk sand is a sedimentary soil, and probably owes its origin to beach deposits. The sand has probably been reworked considerably by the wind since its deposition.

The crops to which this soil is adapted are peaches, small fruits, grapes, berries, and many kinds of vegetables. It is considered a good trucking soil, and is especially suited to sweet potatoes, cantaloupes, and watermelons. Owing to the comparatively slight retentiveness of moisture it is not so well adapted to general farm crops. It is an early soil and is easily worked at all seasons, rarely ever being too wet for cultivation.

Up to a few years ago the only crops grown on this type of soil were cotton and corn, with a few vegetables and some fruit for the use of the farmer and his family. In recent years the farmers living near the railroad have begun to produce some early truck for shipment, while extensive peach orchards are being planted. When first cleared, in favorable seasons, the Norfolk sand will produce from one-fourth to one-half bale of cotton and 15 to 25 bushels of corn per acre. Sweet potatoes yield 100 to 150 bushels per acre, tomatoes 100 bushels, watermelons 1 carload, and cantaloupes one-fourth carload per acre. Plums and berries do well. Within a few years, however, if no attempt is made to maintain the productiveness of the soil, the yields gradually become less, probably because of loss of organic matter. The deficiency may be easily remedied by the plowing under of cowpeas.

The uncultivated soil is covered with a natural growth of "sand-jack" oak, with some black-jack and post oak. This type of soil may be bought for $5 to $15 an acre, depending upon the location and state of improvement.

The following table shows the results of mechanical analyses of typical samples of the Norfolk sand:

Mechanical analyses of Norfolk sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12943	Soil	0.1	10.6	40.0	29.5	6.1	9.7	3.6
12944	Subsoil	.1	30.0	39.0	29.1	5.3	9.3	3.9

NORFOLK FINE SAND.

The Norfolk fine sand consists of about 10 inches of a fine, somesomewhat loamy sand, gray on the surface, but changing to yellow at the depth of a few inches. The subsoil is a yellow fine sand which, at a depth of from 3 to 20 feet, passes into a yellow sandy clay.

Areas of this type are found in all sections of the county, but the largest one is in the northern part of the county, extending from the Anderson County line to several miles south of Grapeland, on the International and Great Northern Railroad. The surface in general consists of gently rolling uplands, having a general elevation of 400 to 500 feet above sea level, and the type is one of the best drained soils in the county. The rolling surface allows the rapid removal of surface water, while the sandy subsoil permits the ready movement of the soil water. The type may be cultivated under a wide range of moisture conditions and is rarely too wet to plow. It is sedimentary in origin, being the remains of old beach deposits of Tertiary age.

The Norfolk fine sand is especially adapted to the growth of early truck crops and is more productive than the Norfolk sand. Grapes, sweet potatoes, and melons do especially well, as do small fruits, such as plums and berries. Peaches do fairly well, but the trees, it is believed, will be comparatively short lived on this type.

In Houston County this type has for years been chiefly utilized for general farming purposes. Cotton, the staple crop, in good seasons yields from one-third to one-half bale per acre. Corn yields at the rate of 15 to 25 bushels per acre. While the adaptation of this soil to the production of vegetables and fruit has long been recognized by the farmers, except for home use it has been utilized for growing truck only near the railroad.

The Norfolk fine sand is deficient in organic matter, although when first cleared it has a small accumulation, and when cropped for several years this is removed and the land deteriorates in productiveness. Organic matter could be added and a higher degree of productiveness maintained by the plowing under of such crops as cowpeas.

Where this type is uncultivated its natural growth consists principally of "sand-jack" oak, with some hickory, "black-jack" and post oak. These oaks, especially the "sand-jack," produce good yields of mast, which is utilized to a considerable extent as feed for hogs.

During recent years some attention has been paid to the production of early truck for shipment to northern markets. The large area of this soil in the northern part of the county is the one upon which this interest has developed, the extension taking place along the International and Great Northern Railroad. The truck growers have been generally successful, and there seems to be no reason why the industry should not become much more important than at present. From 150 to 200 bushels of sweet potatoes, 50 bushels of Irish potatoes, and 100 bushels of tomatoes per acre are fair average yields, and good yields of melons and cantaloupes are also secured.

At the time of making this survey land composed of the Norfolk fine sand, near enough to the railroad to make it available for trucking, could be bought for prices ranging from $5 to $15 an acre, depending upon the state of improvement.

The following table gives the average results of mechanical analyses of typical samples of the Norfolk fine sand:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11435, 12945, 12947.	Soil........	0.0	3.1	9.3	58.6	9.1	14.1	5.1
12946, 12948.......	Subsoil....	.0	2.4	7.9	60.3	8.4	12.2	8.2

NORFOLK FINE SANDY LOAM.

The soil of the Norfolk fine sandy loam consists of a loamy fine sand, ranging from 12 to 30 inches in depth, the average being about 24 inches. The soil for a few inches is gray, but with increasing depth it gradually assumes a pale yellow color. The subsoil consists of a yellow fine sandy loam grading into a sandy clay. The soil and subsoil often contain a small amount of fine sandstone fragments.

The Norfolk fine sandy loam occupies a large part of the county, and is also an important soil west of the International and Great Northern Railroad, in the southwestern part of the county. The largest connected areas are located south of Augusta and Neches, while other large bodies occur southeast of Reynard and around Porter Springs.

The soil occupies a large proportion of the rolling uplands of the county. The surface for the most part is gently rolling, but some areas in the western part of the county are nearly level. The level areas are usually in close proximity to areas of the Lufkin clay or Susquehanna clay, and sometimes the soil merges gradually into these types.

Owing to its rolling and gently sloping topography the greater part of the Norfolk fine sandy loam has excellent surface drainage. The soil itself is of such a loose texture that water readily percolates through it, and in general the underdrainage is good. On the other hand, the sandy clay subsoil is capable of retaining a considerable supply of water during extended periods of dry weather, and the crops on this type withstand drought very well.

The Norfolk fine sandy loam has been formed from the sandy clays of the Jackson stage of the Eocene Tertiary. Erosion has influenced considerably the formation of this soil.

Although the texture of this type of soil is too light for the best results in general farming, it is nevertheless well adapted to the production of a wide range of agricultural products. It is especially adapted to truck, to some extent to peaches, and to a variety of small fruits. In general farming the principal crops grown are cotton and corn, with some oats. Vegetables, tree fruits, and small fruits are grown in a small way, and principally for home consumption. In favorable seasons cotton yields from one-half to three-fourths bale, and corn from 20 to 30 bushels per acre. The yield of oats is moderate, but as the crop is not thrashed definite figures can not be obtained.

This soil is locally called "gray land," and is esteemed by farmers on account of its relatively high productiveness, ease of cultivation, and general utility. The soil responds quickly to fertilization, the effects of which are said to be lasting.

In its virgin state the Norfolk fine sandy loam supports a forest of "black-jack" oak, post oak, hickory, and pine, with other miscellaneous small growth.

Some areas of this soil, located near the railroad, are valued at from $5 to $20 an acre, while those some distance from the railroad may be bought cheaper, depending upon the state of improvement and the value of the timber growth. Where this soil has been used for trucking it has been found to produce, without fertilization, 60 to 100 bushels of Irish potatoes, 100 to 150 bushels of tomatoes, and 200 to 300 bushels of sweet potatoes per acre, and other truck crops in proportion. Handling the soil as is generally done in older trucking districts, these yields should be increased decidedly.

The following table gives the average results of mechanical analyses of the soil and subsoil of the fine earth of the Norfolk fine sandy loam:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12949, 12951	Soil	Tr.	1.2	3.8	60.2	18.5	11.9	5.7
12950, 12952	Subsoil	Tr.	.2	2.1	46.9	10.7	6.2	33.

ORANGEBURG CLAY.

The Orangeburg clay consists of 0 to 4 inches of red, fine sandy loam, underlain by a heavy though slightly sandy clay. Considerable of the type has the clay exposed on the surface, and in fact, little of the type has as much as 4 inches of surface soil. The surface is usually partially covered with ferruginous sandstone fragments, varying from one-fourth inch to several inches in diameter, and like material also occurs throughout the soil and subsoil.

This soil is very limited in extent. Small areas of it are found in the northeastern and northwestern parts of the county, in the vicinity of Augusta, Weches, and Dalys, and in the north-central part around Oriole.

The topography of the Orangeburg clay consists usually of rather steep slopes. These slopes lie between the Norfolk fine sand and the Orangeburg fine sandy loam and are generally denuded of the surface soil by the action of erosion, the soil covering becoming deeper as the slope becomes more gentle, until it merges into the Orangeburg fine sandy loam. Owing to the character of surface the Orangeburg clay is excessively drained, as is evidenced by its usually eroded condition. During dry weather the soil becomes very hard and bakes so that cultivation is difficult.

The Orangeburg clay is a sedimentary soil, derived from Eocene marl deposits, the weathering of which has taken place to a considerable depth. Later erosion has been an important factor in producing the type.

Owing to the fact that most of this type has had its soil removed by erosion little of it is in cultivation. The most of it is covered with a natural growth of red oak, post oak, black-jack oak, and hickory. Where typical it is well adapted to a variety of products. It is quite probable that the better areas of the Orangeburg clay would produce a high-grade domestic filler tobacco.

The Orangeburg clay when cultivated is utilized principally for the production of cotton and corn. In good seasons it produces from one-half to three-fourths bale of cotton and from 20 to 35 bushels of corn per acre. Oats will yield at the rate of 40 bushels per acre. The best phases of the soil would probably produce good yields of wheat. Peaches do well and other fruits would doubtless thrive. It is known as a very early soil, and early vegetables are easily grown. Of course all these statements apply to the areas having a good depth of sandy surface soil and not to the eroded and very stony areas, which constitute the greater part of this soil in the area.

The areas of this type, occurring as they do in long, narrow strips and on usually steep slopes, have no separate money value, but are sold in connection with other adjacent soils.

The following table gives the average results of mechanical analyses of typical samples of the fine earth of the soil and subsoil of the Orangeburg clay:

Mechanical analyses of Orangeburg clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12957	Soil	1.4	3.1	3.7	40.6	18.4	16.2	16.6
12958	Subsoil	.6	2.0	2.4	25.3	10.9	11.1	47.1

ORANGEBURG FINE SANDY LOAM.

The Orangeburg fine sandy loam consists of a red, brown, or gray fine loamy sand or fine sandy loam, with a depth of 4 to 15 inches, underlain by a rather heavy red sandy clay. The soil often contains from 1 to 20 per cent of small ferruginous sandstone fragments, and these same fragments occur to some extent in the subsoil. The greater part of the type has a red surface soil and is locally known as "red land," or where the sandstone fragments are abundant, as "red gravelly land."

The Orangeburg fine sandy loam is found mainly on the uplands in the northern and central parts of the county. Large areas are situated in the vicinity of Dalys, Reynard, and Crockett. The topography is rolling to gently sloping, the surface rarely being level. The soil often occupies the broad and gentle slopes leading down to the larger creek bottoms. The surface is nowhere so rough as to hinder cultivation.

The surface drainage of the Orangeburg fine sandy loam is very good. The gentle slopes allow a ready but not too rapid flow of surface water and erosion is seldom severe, and the light open texture of the soil admits a ready downward passage of soil water. The clay subsoil is retentive of water, and with thorough cultivation the soil retains enough moisture to supply the growing plants during all but the most extended droughts. The land can be worked a short time after ordinary rains and does not become so saturated as to make cultivation impracticable except in extremely wet periods.

The Orangeburg fine sandy loam is derived from marine deposits of the Jackson stage of the Eocene. The removal of the finer particles of the surface soil in the drainage waters has given the light fine sandy loam covering, resting on the original material, a sandy clay, as subsoil.

This type of soil is the strongest and most productive general farming soil in the uplands, and one adapted to a wide range of crops. It responds quickly to good cultivation, being retentive and durable. That it will produce a cigar filler tobacco of excellent aroma and good body has been demonstrated, and that it is also especially adapted to the production of peaches and pears and truck is well known. It is probably the earliest soil in the county and therefore a valuable type to use in the production of vegetables for the northern markets.

Most of the Orangeburg fine sandy loam heretofore has been utilized for general farming purposes, cotton and corn being the principal crops. In favorable seasons cotton yields one-half to three-fourths bale and corn from 25 to 40 bushels per acre. Most of the areas are too far from the railroad to allow best results in truck farming, though in the central part of the county there are relatively large bodies that might be used in this industry. While little trucking has been undertaken on this soil as yet, the results have generally been satisfactory. The principal truck crops grown commercially up to this time are Irish potatoes, yielding from 100 to 150 bushels per acre, tomatoes from 100 to 150 bushels per acre, and cabbage, onions, and sweet potatoes in proportion.

The greater proportion of this soil is in cultivation. The uncultivated land is covered with a forest growth of red oak, black-jack oak, hickory, and some smaller growth. While the most highly prized soil in the county it can be bought for from $6 to $30 an acre, depending upon the distance from the railroad and the state of improvement.

The following table gives the average results of mechanical analyses of the fine earth of typical samples of soil and subsoil of the Orangeburg fine sandy loam:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12953, 12955	Soil	0.9	1.2	3.6	54.6	15.6	14.5	9.5
12954, 12956	Subsoil	.2	1.0	2.1	26.0	12.8	13.9	42.9

ORANGEBURG FINE SAND.

The Orangeburg fine sand consists of from 16 to 36 inches of a red or gray loamy fine sand, underlain by a very sandy red clay or heavy red sandy loam. The soil and subsoil contain small amounts of small ferruginous sandstone fragments or gravel.

The type of soil is limited in extent, one small area being located in the western outskirts of Crockett, and several other small areas, of but few acres each, in the central part of the county.

The Orangeburg fine sand is a very gently rolling and high upland soil. It is well drained on the surface, and the subsoil retains moisture quite well. While the soil is not as productive as the Orangeburg fine sandy loam, it is similar in topographic and drainage features.

This type of soil is derived from the same material as the Orangeburg fine sandy loam, the fine material having in these areas been removed to a greater depth.

The Orangeburg fine sand, although not so strong as the Orangeburg fine sandy loam, is well adapted to a variety of crops. It is probably best adapted to fruit and truck farming, although fair yields of other crops are produced. It is quite probable that this soil is adapted to the production of a high grade of domestic wrapper and filler tobacco.

With good seasons one-third to two-thirds of a bale of cotton and 20 to 25 bushels of corn per acre can be produced on this soil. Large yields of all kinds of vegetables and small fruits are produced. However, owing to the limited extent of this soil in Houston County, it is not an important type.

SUSQUEHANNA CLAY.

The soil of the Susquehanna clay consists of a gray fine sandy or silty loam having an average depth of 6 to 8 inches and being usually free from stone or gravel. The subsoil consists of a heavy red clay, very impervious, and having a rather peculiar greasy feel. This subsoil may be mottled with gray immediately below the soil, or it may grade into a mottled red and gray clay at a depth of from 24 to

36 inches. The proportion of gray clay increases with depth, and at a depth of several feet it is often distinctly stratified. On the surface of the soil small quantities of sandstone fragments or smooth, water-worn quartz gravel are occasionally found. Sometimes the subsoil consists of a heavy yellow clay, which, at a depth of 18 to 24 inches, grades into a heavy mottled yellow, red, and gray clay.

Large areas of the Susquehanna clay are situated in the central part of the county, in the vicinity of Crockett, and west of Crockett there is an extended area containing 15 or 20 square miles. Just south of Belott there is another large area, and the type also occurs in the vicinity of Porter Springs, in the western part of the county. A large and important tract is found in the extreme eastern part of the county northeast of Ratcliff. Small areas are located throughout the central part of the county.

The greater proportion of the Susquehanna clay occupies flat, wooded areas, although some of it adjacent to the streams has a rather rolling topography. It is locally known as "post-oak land," or "post-oak flats."

The Susquehanna clay on the whole is not well drained, although it is so situated that it may be easily drained, either by shallow ditches or by the use of tiles. While streams rarely flow through the areas, there are many which owe their origin to the surface water flowing from this type. These streams are intermittent, but after heavy rains they become swollen with the surface water, little of the rainfall finding its way into the heavy clay subsoil.

The Susquehanna clay has been derived from the underlying clays. These clays were deposited in quiet waters and probably represent a transition from the Jackson to the Lower Claiborne stage of the Eocene.

The uncultivated areas of this soil are covered with a heavy growth of post oak, with some pin oak and small pine. They also support a good growth of wild grass, which is valuable for grazing. The type, it is said, will give a better yield per acre of cotton, where the boll weevil is active, than any other soil in the county, excepting possibly the Lufkin clay. This is due to the fact that the stalk does not make a rank growth, and the rays of the sun penetrate the foliage of the plant, affording the insects no protection from the hot sun, and also to the fact that the ground becomes very hard in dry weather, which, it is claimed, proves disastrous to the weevils, preventing their escape from the hot sun by entering the soil.

The Susquehanna clay is not cultivated to any great extent. Its best yields are obtained only after the land has been in cultivation for two or three years, and, in case of the poorly drained areas, by artificial drainage. In favorable seasons a yield of one-half to three-fourths bale of cotton and 25 to 35 bushels of corn per acre can be secured. Well-drained areas of this type will produce fair yields of peaches, pears, and vegetables. The Susquehanna clay is valued at $3 to $10 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Susquehanna clay:

Mechanical analyses of Susquehanna clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12939	Soil	1.1	1.7	0.8	7.7	11.4	40.3	37
12940	Subsoil	1.7	2.3	.6	6.0	7.6	23.0	58.8

LUFKIN FINE SAND.

The Lufkin fine sand consists of about 10 inches of a gray fine silty sand, underlain by a subsoil of much the same color and texture to a depth of 36 inches. At a depth of from 36 inches to 6 feet the underlying material is a heavy gray or mottled gray and yellow clay, which at lower depths is often stratified. Quartz gravel, rounded and smooth, are sometimes found on the surface or just at the line of contact of the sand and clay several feet beneath the surface, and in the latter position silicified wood is often found.

There are some areas of this soil that are low lying and flat, and here the silt content is larger, the soil somewhat darker colored, and the subsoil somewhat sticky and often mottled with yellow. This heavier phase is found in Nevills, Tyler, and East prairies, and elsewhere as low-lying pine-woods land.

The Lufkin fine sand exists in large connected areas, covering the greater proportion of the southern part of the county and extending over the line into Trinity County. Lovelady, Kennard, Holly, Weldon, and Antioch are surrounded by large areas of this soil.

The Lufkin fine sand occupies gently rolling and nearly level uplands, having an elevation of 200 to 400 feet above sea level. The surface drainage is usually adequate, although considerable areas, level or slightly depressed, become saturated during heavy rains, and the water from these tracts drains off very slowly. The drainage conditions would be greatly improved by ditching. Many small streams originate in this soil, and, combining, form large sluggish streams with broad bottoms, which overflow frequently during the spring, the water moving off very slowly.

The Lufkin fine sand, which is sedimentary in origin, is believed to be derived from the Fayette sands. It is not improbable that the prairie areas of the type were within comparatively recent times the beds of lakes or marshes subject to long-continued inundation, and that the sandy material forming the soil was washed from the surrounding land into these lakes or depressions.

The greater part of the Lufkin fine sand is covered with a forest of pine and an admixture of black-jack oak, red oak, and hickory. The prairie areas, however, are practically all under cultivation. Much of the pine timber is quite valuable.

The Lufkin fine sand is easily tilled usually, though some of the low areas become rather hard in dry weather. It responds readily to fertilization and is much improved by the plowing under of leguminous crops.

It is not a very early soil, though the poorly drained areas can be improved in this respect by ditching. While used mainly for cotton and corn, it is best adapted to fruit, truck, and sugar cane. Cotton yields from one-half to two-thirds bale, corn from 12 to 25 bushels, and sugar cane from 150 to 300 gallons of sirup per acre. Small quantities of fruit and vegetables are grown for home use. Peaches do well, but it has been the experience of some that the trees are short lived. After two or three years of cultivation the soil declines in productiveness unless it is manured. This is particularly the case where sugar cane is the crop grown.

The greater part of this type is not near the railroads, for which reason it has not been possible to develop the trucking and fruit-growing industries to any great extent. However, the farmers in the eastern and southern parts of the county, in the vicinity of the International and Great Northern Railroad, and also in the region about the Eastern Texas Railroad, have begun to grow such truck as tomatoes and potatoes for shipment, with good results.

The timbered land of the type is valued at $5 to $8 an acre, and the improved land at $10 to $15 an acre, depending largely upon the location and distance from railroads.

The following table gives the results of mechanical analyses of the soil and subsoil of the Lufkin fine sand:

Mechanical analyses of Lufkin fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12174	Soil	0.2	0.8	1.0	25.2	56.5	15.4	1.3
12175	Subsoil	.0	.4	1.0	28.5	52.4	15.2	2.8

SUSQUEHANNA FINE SANDY LOAM.

The Susquehanna fine sandy loam consists of 8 to 20 inches of a gray fine sandy loam, underlain by a heavy mottled red and gray clay which has a peculiar greasy feel. Usually the gray color in the subsoil increases with the depth. The soil is generally free from stones, but sometimes a small quantity of sandstone fragments or smooth quartz gravel occurs on the surface and throughout the profile.

This type of soil exists in some large and small areas throughout the central and eastern parts of the county. The largest connected areas are located in the eastern part of the county near Tadmor. The topography is usually gently rolling, and the type often occupies gentle slopes adjacent to creek bottoms, and in this case has a surface similar to that of the Orangeburg fine sandy loam. Many small bodies of but a few acres each occur as slightly elevated ridges or moundlike areas.

Owing to the rolling or sloping surface the type is usually well drained. The subsoil is a very impervious clay, which retains water for a long time. This, together with the fact that the sandy surface soil, if cultivated properly, acts as a kind of mulch during dry weather, enables the crop to withstand drought fairly well.

The subsoil of the Susquehanna fine sandy loam is probably derived from the weathering of the Yegua clays, or Lower Claiborne, while the sandy surface soil is probably the remains of the superimposed Fayette sands.

This type is a productive soil and adapted to a large number of crops. The principal crops grown are cotton and corn. In favorable seasons cotton will yield one-half to three-fourths bale and corn from 20 to 30 bushels per acre. Peaches and pears, as well as all kinds of small fruits and vegetables, make good yields, but as much of this type is distant from the railroads little of it is utilized for the production of these crops.

The natural growth of this type of soil is black-jack oak, post oak, hickory, and pine.

The Susquehanna fine sandy loam is valued at $5 to $20 an acre, depending upon situation with regard to markets and transportation facilities and on the character and condition of the improvements.

The following table gives the results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12985	Soil	0.1	0.3	0.2	54.4	23.9	15.7	5.2
12986	Subsoil	.2	.2	.1	27.7	13.5	17.1	41.4

WABASH CLAY.

The soil of the Wabash clay consists of about 12 inches of a very dark drab or black clay, underlain to a depth of several feet by a heavy clay which usually has the same color as the soil, but which sometimes is a brownish-yellow or mottled yellow clay. The soil and subsoil are free from stones or gravel. Occasional small areas near the river are slightly more sandy, but the sand content is never so great as to modify materially the marked clayey texture of the soil.

This type of soil is found in the western part of the county, and extends from the northern to the southern boundary in an almost continuous strip of low, flat bottom land, from one-fourth to several miles in width, along the Trinity River and between that stream and the uplands. The topography is very nearly level, although the land near the river banks is usually slightly higher than that farther back, making large areas of land slightly basin shaped.

Owing to this level and depressed surface the type is rather poorly drained, and in rainy seasons or after overflows the soil remains for some time too wet for cultivation. A number of creeks and branches flow through the bottoms and offer facilities for drainage by ditching. At present the water all drains off without assistance, so cultivation is possible without artificial drainage, but many areas could be cultivated to better advantage if a system of ditching or tile draining were introduced. Overflows do not occur every year and sometimes not during several years in succession. They may occur, however, at any season of the year, though seldom, except during the winter and early spring months, and even then the water may cover only a small part of the type. Usually the floods recede in time to allow crops to be grown. The soil is inundated for periods ranging from a day to several days, and the depth of water ranges from a few inches on some of the higher lying areas to several feet in the basins next the uplands.

The Wabash clay is alluvial in origin and is derived from the deposition of mineral and organic matter contained in overflow waters of the Trinity River. Most of the materials come from the Black and Grand Prairie regions of north Texas. The decay of vegetable matter, such as leaves, etc., has given a generous admixture of organic matter in the soil and has contributed largely to its productiveness.

The Wabash clay is a very strong and productive soil, and although a large percentage of it is still uncultivated some large plantations consist largely of this type. Where uncultivated it is covered with a heavy growth of ash, elm, pecan, burr oak, and other trees, while some rather open areas, locally called " prairies," have a scattering growth of thorn apple. A good growth of mesquite grass is sustained on this type. This soil is especially adapted to the production of cotton and corn, but since the boll weevil has appeared much damage to the cotton crop is done by the pest, which is thought to be due to the luxuriant growth of the cotton stalk, which shades the ground and protects the weevil from the hot sun.

The crops grown on the Wabash clay consist chiefly of cotton and corn, with the following yields in good seasons: Cotton, 1 bale or more per acre; corn, from 40 to 70 bushels per acre. The yield of cotton stated can be secured only where the boll weevil is not active. The corn yields would be higher if more attention were paid to proper cultivation.

The excellent grazing and heavy yield of mast on the unimproved soil makes the Wabash clay valuable for stock raising. A considerable number of cattle and hogs are marketed from these river bottoms yearly. Alfalfa would probably do well on the best drained areas.

The Wabash clay at present has a low valuation, owing to its distance of 14 to 20 miles from the railroads, and may be bought in large tracts at $3 to $10 an acre, depending upon the state of improvement.

The following table gives the average results of mechanical analyses of the samples of the soil and subsoil of the Wabash clay:

Mechanical analyses of Wabash clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12965, 12967	Soil	0.0	1.4	1.3	6.3	3.5	33.9	53.2
12966, 12968	Subsoil	Tr.	1.1	.8	4.4	2.8	31.8	56.6

YAZOO SANDY LOAM.

The soil of the Yazoo sandy loam consists of about 12 inches of brown sandy loam, underlain by a brown light sandy clay. The texture is not uniform, and the soil is not typical in this county, as it is made up of heterogeneous mixtures of sand with the Wabash clay, the surface soil usually being more sandy than the subsoil.

The Yazoo sandy loam occurs in a few small areas in or near the outward margins of the Trinity River bottoms, the largest areas being situated near Clapps Ferry, in the southwestern part of the county. The areas are associated with the Wabash clay and the Sharkey clay.

The topography of the Yazoo sandy loam varies from level to very gently rolling, the surface being slightly higher than the surrounding Wabash clay. The drainage is fairly good, although the surface may be overflowed for a short time in unusually high floods.

The Yazoo sandy loam is formed in the same way as the Wabash clay, with the difference that the suspended material was deposited from more swiftly moving currents. Some areas of this soil have been formed by the sand of the immediate uplands being washed down onto the Wabash clay.

This type of soil is adapted to the production of cotton and corn. Cotton will yield from $\frac{3}{4}$ to 1 bale, and corn 30 to 50 bushels per acre. These yields show the type to be naturally productive, though it is not so desirable as the Wabash clay. Vegetables and fruit should do well upon it, but for these crops the sandy soils of the uplands are better. The Yazoo sandy loam is relatively unimportant agriculturally, because of its limited extent. It is held at about the same price as the Wabash clay.

YAZOO LOAM.

The Yazoo loam consists of a brown loam or silty loam, sometimes rather heavy in texture to a depth of about 12 inches, underlain by a heavy brown loam or clay loam, and again extending to a depth of 3 feet or more with little change of texture. The heavy loam phase is found only in the Trinity River bottoms. The river bottom phase is very limited in extent, the most of it being situated near Clapps Ferry in the southwestern part of the county. The greater part of the type occupies the broad bottoms of the Hurricane Bayou, Tantabogue, White Rock, Gail, Cane, and other creeks in the southern part of the county.

The surface is level and usually low lying and the water stands on it for a considerable time after floods, though the natural drainage is such as to fit the land for cultivation. Crops produce the best, however, on areas where the drainage is assisted by open ditches. The creek bottoms are overflowed much oftener than the river bottom, but the areas of this type are covered with the water for only a few hours at a time.

The Yazoo loam is alluvial in origin, being derived from the deposition of sediment from rather more swiftly moving overflow water than that from which the Wabash clay was laid down.

The soil is essentially adapted to the production of cotton and corn, and though the boll weevil is very destructive these are the two principal crops grown. Cotton when not attacked by the weevil yields about 1 bale per acre and corn from 40 to 60 bushels per acre. On the lighter-textured creek-bottom areas sugar cane is grown, yielding from 200 to 400 gallons of sirup per acre.

Some of the Yazoo loam is well located with reference to transportation facilities, while other areas of it, especially those in the river bottoms, are from 15 to 20 miles from the railroad.

A great part of this type of soil is not in cultivation, but is covered with a heavy growth of sweet gum, pin oak, water oak, ash, elm, etc. It brings from $5 to $10 an acre. In some localities it is valued more highly than the adjacent upland soils.

LUFKIN CLAY.

The Lufkin clay consists of from 3 to 8 inches of a gray silty or fine sandy loam, underlain by a heavy gray or mottled gray and yellow clay. The soil occasionally contains a small amount of iron concretions. Considerable quantities of siliceous gravel and silicified wood are found on the surface in certain localities. This soil is locally termed "post-oak flats," or "post-oak swags," from the timber growth and topography.

The Lufkin clay exists in many large and small areas in the western and southern parts of the county. The "post-oak swags" are located in the western part of the county on the uplands near the Trinity River bottoms. Some areas are found in Nevills Prairie in the southwestern part of the county, and here the subsoil is sometimes quite dark in color. In the vicinity of Lovelady also some large areas occur.

This type of soil usually occupies low, flat, and poorly drained areas, although sometimes the surface is gently rolling. The "post-oak swags" in the western part of the county are low basin-shaped areas, which, after heavy rains, form the beds of small lakes.

The surface drainage of the Lufkin clay is generally poor, while the heavy clay subsoil is very impervious and allows little or no passage of water downward, causing water to stand on the surface for days at a time. Many areas may be easily drained by ditching, as numerous small streams, which slowly drain the water from the surface, are available as outlets. Tile drainage would be of great benefit, but ordinarily ditching would be sufficient.

The Lufkin clay has been derived from the underlying clays. Kennedy considered these clays as lacustrine in origin, probably representing old lake beds, which at a still earlier time formed a part of the bed of some river.

Some small areas of this soil on the rolling prairies have had the surface soil removed by erosion, and here the productiveness of the soil is greatly impaired. These eroded spots are termed "putty land." A large proportion of the type is not in cultivation, but is covered with a heavy growth of post oak, interspersed with small pine and in the lower places some pin oak.

On account of the poorly drained condition of the Lufkin clay it was for a long time considered almost worthless agriculturally, but in recent years the true value of the soil and its natural productiveness have begun to be appreciated. When first cleared it is in a sour and cold condition, but after two or three years of cultivation it produces quite well, the improvement being mainly due to the aeration of the soil effected through the removal of the excess of water.

It has been found that this soil, like the Susquehanna clay, will produce some cotton in spite of the boll weevil, which is explained by the lack of protection afforded the insects on account of the small growth of the cotton stalk and by the compact condition of the soil. The principal crops grown are cotton and corn, with some oats. In good seasons cotton yields one-half to three-fourths bale, corn from 20 to 30 bushels per acre, and oats in proportion. Peaches, small fruits, and vegetables do fairly well on this soil, but it is not best adapted to these crops.

Much of this type is far from the railroad. It is valued at $3 to $10 an acre, depending upon location and improvements.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Lufkin clay:

Mechanical analyses of Lufkin clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12170, 12172, 12959.	Soil	0.2	0.5	0.7	18.8	30.0	34.9	14.5
12171, 12173, 12960.	Subsoil	.1	.2	.4	11.6	18.7	27.8	40.5

CROCKETT CLAY LOAM.

The Crockett clay loam consists of 12 to 18 inches of a dark-brown or black clay loam, underlain by a mottled drab and red, and sometimes yellow, clay loam. The soil and subsoil contain a small proportion of fine, smooth gravel or iron concretions. At a depth of several feet is found a brittle gray material, which has much the same texture as soft soapstone rock and which is sometimes stratified.

Only a few areas of the Crockett clay loam are found in Houston County, the largest of which, containing between 4 and 5 square miles, occurs several miles southwest of Crockett, forming the greater part of Mustang Prairie. Two other smaller areas are found about 1 mile southeast of Crockett. Some of this type is also found near Percilla and Augusta, in the northern part of the county.

The topography of the soil is gently rolling to level, and surface drainage is fairly good, though some areas could be improved by ditches or tile drains. However, the type can be successfully cultivated without artificial drainage.

The origin of the Crockett clay loam is not well understood, but it is probable that the soil was formed by the weathering of some calcareous material, perhaps an impure limestone. It seems to have many points in common with the Houston black clay. It often merges into the Susquehanna clay, and is sometimes termed "black post-oak land."

Excepting the small areas in the vicinity of Percilla, which, it is claimed, are not adapted to the production of cotton, this type of soil is best adapted to cotton, corn, grain, and grass. The principal crops grown are cotton, corn, and oats. Cotton yields from one-half to 1 bale, and corn from 20 to 30 bushels per acre. The yield of oats is about 40 bushels per acre. It would be well to try alfalfa on this soil, as it is thought this legume would do well. Fair yields of wheat could also be grown, as well as, in all probability, some other grains. Grass is also a crop well adapted to the type, and some excellent grazing is afforded at present.

The Crockett clay loam ranges in value from $8 to $20 an acre, depending upon location.

The following table gives the results of mechanical analyses of the fine earth of soil and subsoil of the Crockett clay loam:

Mechanical analyses of Crockett clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12931	Soil	0.8	2.0	1.2	12.0	20.2	37.3	26.3
12932	Subsoil	.7	2.1	1.2	10.7	15.3	39.4	29.8

HOUSTON BLACK CLAY.

The Houston black clay consists of 12 to 18 inches of a brown or dark-gray clay, underlain by the same material or by a yellow clay. Sometimes lime concretions are found in the soil and subsoil.

But a limited area of this soil is found in Houston County. It is all in the western and southwestern parts of the county on the upland slopes adjacent to or near the Trinity River bottoms. The largest area, including about 4 square miles, lies in the extreme southwestern corner of the county, which, with a few small areas, comprises all of this soil encountered in this survey.

The topography of the Houston black clay is gently rolling and sloping. Its surface drainage is good, but ditching is necessary in some places to secure the best results.

The Houston black clay is probably derived from the weathering of a soft limestone, although the soil was weathered to a considerable depth and no underlying rock was noticed. It is especially adapted to the production of cotton, corn, and grain, and the principal crops grown are cotton, corn, and oats. Cotton yields one-half to 1 bale and corn 20 to 30 bushels per acre. Good yields of oats are produced, and wheat, other grain, and alfalfa, if grown, would, it is thought, produce well.

The Houston black clay is valued at $10 to $15 an acre, depending upon the state of improvement.

The following table gives the results of mechanical analyses of the soil and subsoil of the Houston black clay:

Mechanical analyses of Houston black clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12933	Soil	0.4	1.6	1.2	6.7	4.9	35.8	49.2
12934	Subsoil	.6	1.3	1.1	6.8	4.3	32.6	53.8

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12933, 3.22 per cent; No. 12934, 4.85 per cent.

SHARKEY CLAY.

The Sharkey clay consists of a few inches of gray silty loam, underlain by a very heavy waxy yellow or mottled yellow and gray clay, or it may have the yellow clay exposed on the surface. It is a soil of limited extent in Houston County, and exists in small areas in the Trinity River bottoms, in the vicinity of Reynard and Cains Ferry.

The areas are low and basin-shaped, and overflow waters stand for a long time after the floods have receded from the surrounding Wabash clay areas.

The Sharkey clay has been formed by deposition of the finest particles carried by the Trinity River. Owing to the poor drainage conditions the type is not cultivated, and as it is so unimportant and the texture is so variable no samples of it were taken. If well drained this soil might produce good crops of cotton and corn, but now it is considered almost worthless.

MEADOW.

The Meadow has little uniformity of texture, but more often consists of a light silty or fine sandy loam, having a depth of 3 feet or more. It occupies the bottom lands of many of the creeks and their larger branches. The largest areas are found along the Elkhart, San Pedro, Hickory, and Piney creeks, and Cochino Bayou. These bottoms range from one-eighth to three-fourths of a mile in width. The soil along the smaller streams is quite sandy, but along the larger streams, which have wider bottoms, the sand content of the soil is not nearly so great; in other words, the sandy texture of the soil is proportional to the size of the stream along which it occurs.

The topography of this soil is quite level. At times the drainage conditions are poor, but the soil can be cultivated with comparatively little ditching, or even without artificial drainage. The Meadow is subject to overflow at any season of the year, though this rarely occurs except in winter or early spring. These overflows seldom cover the surface for more than a few hours at a time.

The Meadow is alluvial in origin, representing deposits from overflow of material gathered from the surrounding upland soils of the country.

The greater proportion of this type is not cultivated, but is covered with a heavy growth of sweet gum, water oak, pin oak, elm, ash, and other smaller growth. Where cultivated it is highly prized as a cotton, corn, and sugar-cane soil. The boll weevil, however, is very destructive to cotton on this type. Crops are seldom damaged by overflow, and were it not for the boll weevil a bale of cotton could easily be secured per acre. Corn will yield 40 to 60 bushels, and sugar cane 300 to 500 gallons of sirup per acre. The Meadow areas are especially adapted to sugar cane, and nearly all the sirup manufactured in Houston County is from cane grown on the Meadow soil. It is made by the farmers and is of very fine quality, finding a ready sale at 40 to 50 cents a gallon, and constituting a considerable source of revenue to many farmers. Sorghum is not planted to any great extent on this soil, but on the various upland soils.

The Meadow is valued highly, and in some sections of the county the price is higher than for the adjacent upland soils. In other places it may be bought for $3 to $8 an acre, depending upon its improvement.

No samples of this type were collected for analysis, as the classification is based on the position and drainage conditions rather than on the texture.

AGRICULTURAL CONDITIONS.

The agricultural resources of Houston County are by no means developed. In a total area of 762,752 acres, or nearly 1,192 square miles, but 425,167 acres, or something over half, is included in farms, and of this area only 174,444 acres is improved. In other words, not quite 23 per cent of the area of the county has been brought under the plow. The remainder, which is largely in forest of some description, is not without value to the farmer, however, as it affords pasture for cattle and hogs.

One reason, probably the main reason, why a larger proportion of the land of Houston County is not cultivated is the lack of transportation, many parts of the county lying from 15 to 20 miles from the two railroads now available, but even near these railroads, although great progress has been made along certain special lines, the opportunity for profitable investment and for greater returns from the land has not been exhausted.

So favorable are the soil and climatic conditions for agriculture in general, and for stock raising in particular, that the farmer can make a living with a minimum of exertion and expense, and this is responsible for a certain contentment among the farming class that does not make for rapid progress or the acquirement of independent fortunes. Nevertheless, the more ambitious farmers are meeting with financial success, especially where their farms are situated near the shipping points and where specialties like fruit growing and trucking have been taken up.

According to the Twelfth Census the value of the farm land and improvements, except buildings, was $2,080,760, and the total value of buildings on farms $680,000. The buildings generally consist of small unpainted structures, although many comfortable houses, with well-kept surroundings, are scattered through the county. The size of the farms in the uplands ranges usually between 150 and 400 acres, though often the actual area under cultivation is only 25 to 60 acres, the remainder consisting of woodland and pasture. A few large plantations in the bottoms of Trinity River comprise many hundreds, and some of the largest several thousand, acres, all under cultivation.

About one-half the farms are operated by the owner. Where worked by tenants some system of shares is the usual arrangement. Two prevailing plans are locally known as the " half " or the " third and fourth systems." Under the former arrangement the owner furnishes the land, buildings, stock, and farming implements, the tenant supplying only the labor, the basis of settlement being one-half of all crops. In the " third and fourth " system the owner furnishes only the land and buildings, the tenant everything else, and in this case the rent is one-third the corn and one-fourth the cotton produced. A cash rent for the use of land is sometimes paid, the price per acre being $3 a year. Many of the tenants shift from place to place each year, but a few stay year after year on the same farm. Tenants of the latter class are more desirable, as they take greater interest in keeping the farm in good condition.

The value of the live stock in the county in 1899 was over $850,000, the most of this representing the work stock and other farm animals on each farm, few individuals owning large herds.

The cotton produced in 1900, 27,619 bales of 500 pounds each, averaged a little less than one-half bale per acre, but since the appearance of the boll weevil the average yield has declined considerably. The average yield of corn was nearly 14 bushels.

The labor on the farm in this county is drawn principally from the negro race, although some white labor is used. Some farmers with their families do their own work during the whole year or the greater part of it, hiring help only during very busy seasons—that is, in the spring when the cotton is chopped (thinned and hoed) and in the fall when the cotton is picked. At these times negro men, women, and children are employed, being paid by the day for the chopping and at a stated price per hundred pounds for picking.

Labor is paid from 50 to 75 cents per day with partial board, and sometimes more than this. A few farmers hire help by the month during the entire year, paying for such labor about $15 a month with board. Good labor is often scarce and much difficulty is sometimes encountered by the farmers in obtaining help at the proper time.

The principal crops grown in Houston County have always been cotton, corn, and a small amount of oats. Some vegetables and fruits have been grown for home use, principally Irish and sweet potatoes, tomatoes, turnips, cabbage, etc., and peaches, pears, plums, grapes, and berries. In recent years the production of fruit and truck for northern markets has gradually increased in the vicinity of shipping points along the railroads. Considerable quantities of Irish potatoes are shipped from Crockett and other railroad points every spring, and large orchards of peaches and pears are being set out.

The stock-raising industry has been followed since the early history of the county, and still constitutes an important source of revenue. The stock raised consists principally of hogs and cattle, which are shipped from the county in carload lots. The value of the poultry products is also an important item, large shipments of chickens and eggs to the near-by cities constituting a source of considerable revenue.

On the other hand, a considerable quantity of hay is imported into the county, which might well be produced locally, and there is here excellent opportunity for profitable extension of agriculture along a line heretofore but little followed.

Although it has long been generally recognized by the farmers that the soils of Houston County are adapted to a wide range of crops, the conditions of marketing, labor, and commercial wages have compelled the making of cotton and corn the chief crops. It is generally understood that the soils of the Orangeburg and Norfolk series are best adapted to the production of fruit and truck crops; that the soils of the bottom lands are best adapted to cotton and corn; that the Houston black clay is best adapted to cotton and grain, and that the Meadow soil is especially adapted to sugar cane.

Experiments recently made by the Bureau of Soils have demonstrated that the Orangeburg soils are adapted to growing a superior quality of domestic cigar filler tobacco, and present indications seem to point to the establishing of this industry on a commercial basis.

The International and Great Northern Railroad runs through the county in a north and south direction, the main shipping points being Crockett, Grapeland, and Lovelady, with Latexo, Paso Switch, and the Natalie Plantation Switch of less importance. In the eastern part of the county the Eastern Texas Railroad reaches as far as Kennard, about 15 miles of the line being in Houston County. The shipping points on this railroad are Kennard, Kennard Mill, Fife Switch, and Druso Switch. These railroads afford connections with many important markets.

Dirt roads lead out of Crockett in all directions. In rainy seasons all of them, except those in the sandy areas, are in bad condition. With the available supplies of sand and clay it is possible to have a fairly good road system in the county. Better roads would aid greatly in improving the agricultural conditions generally by affording easier and quicker communication with the markets and railroads, and the value of the land all over the county would be greatly increased by the same means. There are several rural free delivery mail routes operated out of Crockett, Grapeland, and Lovelady.

There are no large markets in Houston County, although Crockett, Grapeland, and Lovelady consume a part of the produce. Crockett is the county seat and the largest town, having a population of about 3,000. The nearest large markets are Houston, Galveston, Dallas, and Fort Worth, which are easily reached by rail. Good connections are made with railways reaching the larger markets in the North and East.

Kennard Mill, a sawmill town on the Eastern Texas Railroad, is the site of a sawmill, one of the largest in the South, with a capacity of 300,000 feet of lumber a day. The company operating the mill owns large tracts of land in the eastern part of the county and employs a large force of men.

SOIL SURVEY OF THE WACO AREA, TEXAS.

By A. W. MANGUM and M. EARL CARR.

LOCATION AND BOUNDARIES OF THE AREA.

The Waco area is located in the Black Prairie Belt of east-central Texas. It is rectangular in shape, being bounded by the parallels of 31° 30′ and 31° 45′ north latitude and the meridians of 97° and 97° 30′ west longitude. The area thus embraced is 29½ miles long and 17 miles wide, making a total area of 316,864 acres, or about 495 square miles. The main body of the area lies in McLennan County, although about 50 square miles in the northwestern corner lies in Bosque County.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Several surveys were made and a great many claims were located in the area during the period 1840 to 1845, but there were very few inhabitants except Indians until 1848. In 1849 a number of white settlers arrived and established a village at Waco Springs, which later became the county seat of McLennan County. McLennan County was formed from parts of Limestone, Navarro, and Milam counties on January

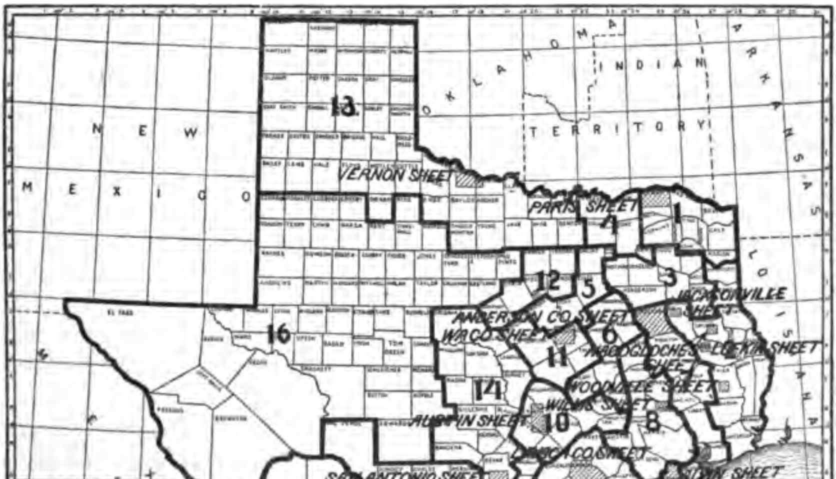

Fig. 23.—Sketch map showing location of the Waco area, Texas.

22, 1850, and thereafter the settlement of the area progressed rapidly and the population of the county increased from a few hundred in 1850 to 6,200 in 1860, and to 13,500 in 1870.

During the next decade the railroads reached the area, establishing communication with the eastern States and with the older settlements in Texas. Many new settlers soon began to arrive from Tennessee, Georgia, and other States farther east, causing the agriculture of the county to develop rapidly and resulting in a great increase in the value of farm and grazing lands.

The bottom lands along the larger streams were the first to be put under cultivation, as the treeless prairies were used exclusively as open ranges for cattle. The lands of the area were primarily taken up for the purpose of stock raising, the abundance of native grasses on the rolling prairies and the large number of small streams which flow through the section making the country especially adapted to this industry, but there has been a steady agricultural development until farming is now the chief industry. As the acreage of cultivated lands increased the area of the open ranges was gradually reduced, and the larger herds of range cattle gave way to smaller herds of improved stock. At the present time only the more stony or shallow types of soil, which are least adapted to agricultural purposes, are utilized as grazing lands for cattle, and the larger stock ranches are located in the more broken and hilly section of the area.

Wheat, corn, and cotton were at first the principal crops grown, although oats, rye, potatoes, and vegetables were also cultivated to some extent. The acreage of almost every crop grown in the county has greatly increased within the last fifteen years, but cotton is the staple crop, and a large proportion of the cultivated land is devoted to its production. The acreage of cotton, corn, and wheat in 1891 was estimated to be, cotton 51,537, corn 28,244, and wheat 3,582 acres, while the census of 1900 gives the acreage of these crops as cotton 170,854, corn 91,189, wheat 31,485 acres, and also shows a large increase in the production of oats, rye, potatoes, vegetables, forage crops, and orchard products.

There is one city and a number of small towns and villages in the area. These contain a considerable proportion of the total population, but the rural districts, with the exception of the rough and more broken sections in the northwestern part of the area that are utilized for grazing purposes, are fairly well settled, and there is a constant demand for the better grades of farming land at good prices.

The rapid agricultural development of the area has been largely due to its central location and to the fact that profitable yields of cotton can be annually obtained on almost any type of soil in the area without the aid of commercial fertilizers and at a comparatively small cost for labor.

There are now 571,345 acres of farm land in McLennan County, of which 385,672 acres are improved, and the total valuation of the farms and improvements, not considering the buildings, is given by the census of 1900 as $12,152,210.

CLIMATE.

The climate of this part of Texas is, as a rule, mild and agreeable during the entire year. The rainfall is distributed rather evenly through the year, being greatest, however, during the spring months or growing season, when it is most needed. Sometimes severe droughts occur, but seldom before the grain crops have matured and are harvested. Cotton, being more resistant, is generally not much damaged by these droughts. The shallow soils of the grazing land in the western part of the area are most affected.

The winters are usually mild and open. The mean minimum temperature for January, the coldest month, being 16.1° F. above the freezing point. The most characteristic feature of the winter climate of this section is the "norther"—a cold wind that sweeps in from the higher latitudes without warning and lowers the temperature many degrees in an incredibly short time. These winds are sometimes accompanied by sleet and snow and cause considerable suffering and loss of life to the exposed cattle.

Sometimes in summer the opposite extreme is experienced and crops suffer materially from the hot, dry winds. Usually the extreme heat of the summer months is somewhat modified by the movements of the air, and the hot days are nearly always followed by cool, restful nights.

The following table, compiled from the records of the Weather Bureau, gives the mean annual and monthly temperature and precipitation for Waco and Temple. Temple is located about 30 miles south of the area:

Normal monthly and annual temperature and precipitation.

Month.	Waco.		Temple.		Month.	Waco.		Temple.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	*Inches.*	*° F.*	*Inches.*		*° F.*	*Inches.*	*° F.*	*Inches.*
January	48.1	2.73	46.9	2.73	August	84.8	2.08	82.6	1.99
February	50.0	1.93	49.0	1.74	September	78.4	2.90	76.9	2.65
March	58.6	3.04	57.6	2.67	October	68.3	2.41	69.2	2.52
April	67.8	4.49	68.7	4.01	November	57.3	2.79	56.9	2.89
May	75.7	3.64	73.6	3.68	December	51.0	2.06	49.7	2.92
June	82.4	2.70	80.0	4.13	Year	67.3	32.77	66.2	34.77
July	85.4	2.00	83.0	2.84					

The following table, compiled from the same source, gives the date of the last killing frost in spring and the first in the fall for the past eight years.

From this table it will be seen that the shortest growing season, 219 days, occurred in 1899, and the longest, 274 days, in 1896, the average being about 250 days, or a little over eight months:

Dates of first and last killing frosts.

Year.	Waco.		Temple.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1896	Feb. 7	Nov. 8	Mar. 16	....
1897	Mar. 24	Nov. 18	....	Nov. 16
1898	Mar. 24	Nov. 23	Mar. 23	Nov. 21
1899	Mar. 29	Nov. 3	Apr. 9	Nov. 2
1900	Mar. 2	Nov. 10	Mar. 15	Nov. 11
1901	Mar. 6	Nov. 5	Mar. 5	Nov. 4
1902	Mar. 6	Dec. 4	Mar. 6	Nov. 26
1903	Mar. 2	Nov. 18	Mar. 2	Nov. 17
Average	Mar. 9	Nov. 15	Mar. 15	Nov. 14

PHYSIOGRAPHY AND GEOLOGY.

The greater part of the area, on both sides of the Brazos River, consists of rolling upland prairies intersected by numerous small streams and rivers. These prairies have a general tendency to slope toward the Brazos and slightly southeast with the direction of the river. The general appearance of the upland prairies is that of a gently undulating plain, but the low, rounded hills with gentle slopes and shallow intervening depressions give them a gently rolling topography.

Along the small streams and rivers which traverse the prairies of the western section of the area the topography becomes rougher and more broken and the soils suffer to a considerable extent from the effects of erosion, causing them to be shallow, stony, and of low agricultural value. Here the slopes of the rounded hills become steeper and many draws and deep erosions extend from the more level prairies to the narrow bottoms along the stream courses. In this section of the area the streams that flow through the rolling prairies have cut their channels a considerable depth below the level of the neighboring uplands. There is frequently a narrow strip of level bottom land between the present channel of the stream and the precipitous bluffs which extend upward to the adjacent prairie, but many of the streams flow between almost perpendicular walls of limestone, which rise to an elevation of 50 to 75 feet above stream level and which seldom widen out sufficiently to permit of any alluvial bottom lands.

The highest point in the area is on the rolling plateau in the northwestern part of the area, where some of the rounded hills reach an elevation of from 750 to 800 feet. The topography of this section is slightly more hilly than the greater part of the prairie, and many of the rounded hills have a slightly terraced appearance. The soil on the steeper slopes and on the rounded summits is seldom more than 1 foot deep, and small areas frequently occur where the soil has been entirely eroded off and the underlying limestone is exposed on the surface. The lowest point, where the Brazos River leaves the area, has an elevation of about 400 feet above sea level.

One of the principal topographic features is the escarpment of Austin chalk that extends across the area from northeast to southwest, crossing the Brazos River above Waco. The western boundary of the escarpment rises abruptly many feet above the gently rolling prairie to the west in a series of steep and precipitous limestone hills, intersected by many deep and narrow gorges. The soil along the western slope is shallow and easily eroded and frequent exposures of the white chalky limestone occur along the hillsides and deep erosions. The narrow strip of country occupied by this chalky formation has a slightly more rolling topography than that of the greater part of the prairie section, and where the Brazos River or small streams have cut their channels through this formation, they flow between high, perpendicular bluffs of soft white limestone. The eastern boundary of the Austin chalk escarpment is much less distinct, the chalky hills passing gradually into the low, rolling topography of the upland prairie. A series of old river terraces extends along each side of the Brazos River, except where this stream has cut its channel through the chalk escarpment. These terraces have a level or very gently undulating topography and are composed of material deposited by the stream in comparatively recent time. Flood waters originating in or traversing the Permian red beds have brought down a large amount of this material, which causes these valley lands to have a red to reddish-brown color. The remnant of an older alluvial formation occurs along the low ridges and rounded elevations adjacent to these bottom lands. This frequently contains a large percentage of rounded, waterworn gravel, and owes its origin to material deposited by floods at a much earlier period. This deposit is of no great extent on the western side of the Brazos River, but covers a considerable area on the eastern side. It overlies the older geological formations to a depth varying from a few feet to about 40 feet and often has an elevation of more than 100 feet above the present valley of the river. The smaller rivers and principal creeks, with the exception of those traversing the western part of the area, flow through broad, flat alluvial valleys which have only a slight elevation above stream level.

With the exception of these alluvial deposits, the geological formations from which the soils of the area are derived belong to the Gulf series of the Upper Cretaceous and to the Comanche series of the

Lower Cretaceous period. The entire western half of the area is underlain by the Fort Worth limestone, which forms by its disintegration the soils of the rolling prairie in that locality. This formation belongs to the Lower Cretaceous and consists of a group of impure, slightly arenaceous, compact white limestone strata, separated by layers of argillaceous lime marl. The compact layers often reach a thickness of several feet, but the average thickness varies from a few inches to about 2 feet. The difference in the weathering of these alternating layers of hard limestone and softer marly material has caused the slightly terraced appearance of the slopes of the higher elevations in the western part of the area.

The Fort Worth formation is encountered at no great depth below the surface, even on the more level portions of the prairie, and where the topography is very rolling it outcrops frequently and seldom has more than a shallow covering of soil.

The Denison formation of the Lower Cretaceous has entered largely into the composition of the soil in a small area situated just north of the Bosque River. It consists of laminated ferruginous clays, sandy clays, and impure limestone. A few fragments of sandstone are also encountered in the upper soil. The soils derived from this formation contain a larger proportion of sand than those originating from the Fort Worth limestone and usually have a slightly redder color.

The Austin chalk, which forms the escarpment already mentioned as extending across the area in a northeast-southwest direction, is a stratified chalky limestone, the strata varying in thickness from 1 foot to about 8 feet. Pockets of marl occur in this formation and layers of marl frequently separate the limestone strata. The Austin chalk is very fossiliferous and also often contains many small concretions of iron pyrite embedded in the strata. It weathers rapidly and forms a black clay soil, which is estimated to vary in depth from 1 foot to more than 30 feet. The small streams cut rapidly through this soft formation and flow in deep canyonlike erosions with almost perpendicular walls. The thickness of this chalky formation in the area has been estimated to be from 35 to about 170 feet. Lying immediately under the Austin chalk and outcropping along the western boundary of the escarpment is a series of blue laminated clays and blue argillaceous shale, known as the Eagle Ford formation. Where this formation is exposed it also weathers rapidly into a stiff black clay soil. The rolling black prairie lands, south and east of Waco, are underlain by the Taylor marl. This, together with the Austin chalk and Eagle Ford formations, belongs to the Gulf series of the Upper Cretaceous. The Taylor marl consists of massive beds of calcareous clay marls, which are sometimes known as joint clays. These marls are yellowish in color and are said to have a laminated structure, but they weather rapidly to a considerable depth and appear compact and massive.

Every section of the area, with the exception of a few small depressions in the flat bottom lands along some of the smaller streams, has good natural drainage. The Brazos River flows through the area in a general northwest to southeast course and serves as the outlet for the drainage waters of the entire area. The drainage waters of the western half of the area reach the Brazos through Childress Creek and the Bosque River. Hog Creek and the Middle Fork of the Bosque, which empty into the South Bosque, drain the southwestern part of the area. Childress Creek drains a considerable part of the northwestern section of the area and empties directly into the Brazos River. The North Fork of the Bosque carries off the drainage waters of the west central section. It unites with the South Bosque about 5 miles northwest of Waco, forming the Bosque River, which empties into the Brazos River about 3 miles above that city.

The rolling country east of the Brazos River is intersected by many small streams that flow in a general southerly direction. Those east of the Houston and Texas Central Railroad finally empty into Tehuacan Creek, which receives the drainage water of the extreme eastern section of the area and empties into the Brazos River a short distance south of the area. Whiterock and Aquilla creeks, together with their small tributaries, drain a large proportion of the northeastern part of the area.

SOILS.

Sixteen types of soil were mapped in the area. Five are derived directly from the decomposition of the geological formations of the Cretaceous period, which underlie the area, eight are derived from material deposited by stream, either in comparatively recent time or during floods which occurred at an earlier date, and two are composed of transported material combined with that derived from the weathering of the underlying formations.

The following table shows the total area embraced by each type:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Crawford clay	112,320	35.5	Yazoo clay	7,488	2.4
Houston black clay	57,280	18.1	Crawford loam	6,784	2.2
Crawford stony clay	27,264	8.6	Miller heavy clay	4,608	1.5
Susquehanna fine sandy loam	24,512	7.7	Rock outcrop	2,880	.9
Miller fine sandy loam	22,208	7.0	Houston gravelly clay	1,984	.6
Yazoo heavy clay	13,248	4.2	Miller fine sand	1,408	.4
Houston clay	12,864	4.0	Miller silt loam	960	.3
Travis gravelly loam	12,416	3.9	Total	316,864	
Houston loam	8,640	2.7			

HOUSTON BLACK CLAY.

The Houston black clay, locally known as "black waxy prairie land," is one of the most productive soils in the area. To a depth of 10 inches the soil is a black to very dark drab clay, sticky and tenacious when wet, but friable and loamy when in a well-cultivated condition. The fine tilth is particularly noticeable in areas that have been under cultivation for a considerable time, where the upper part of the soil is loose and friable, though in its virgin state or in areas utilized for grazing purposes the surface becomes hard, baked, and sun cracked. The soil grades at about 10 inches into a stiff, tenacious dark-drab to slate-colored clay, which becomes stiffer and slightly heavier as the depth increases, and at 36 inches is a very stiff compact clay of a slightly lighter color than the upper part of the section. Upon drying, a very thin, baked crust is frequently formed on the surface, which has a grayish or slate-colored appearance.

The heaviest phase of this soil occurs in the low depressions of the rolling prairie, which are not so thoroughly drained as the greater part of the type. The upper soil in these depressions is usually of a darker color, and upon drying it becomes baked and sun cracked to a greater degree than that of the better drained areas. Again, where this type borders on some of the sandier soils, the texture is often lighter than the typical section would indicate and the surface soil frequently contains a slightly larger proportion of sand. Where these conditions exist to any great extent, or where enough sandy material has been combined with the clay to alter materially the texture, the areas have been classified and indicated on the map as a distinct soil type. In like manner, very small areas occurring on the summits of the higher elevations in the northeastern part of the area surveyed and having loose rounded gravel scattered over the surface have been classified separately where they are of sufficient extent.

With the exception of the western one-fourth of the area the Houston black clay occurs in bodies of more or less extent in almost every part of the survey. The largest unbroken tract occurs south and southwest of Waco, but this type also covers a large proportion of the rolling prairies in the eastern and northeastern sections of the area. Two other tracts of considerable extent occur in the west-central part of the territory surveyed, one lying southwest of Speegleville, and the other occupying the rolling prairie just south and east of China Spring.

The general appearance of the black prairie region occupied by this soil type is that of a very gently rolling plain. The topography varies from an almost level plain to low, rounded hills, with level or very gently undulating areas intervening. In the northeastern part of the area the surface is slightly more rolling, but the hillsides are never steep and very little erosion takes place.

The Houston black clay has good natural drainage and can be cultivated within a comparatively short time after heavy rains, the rolling topography serving to carry the excess water to the many small streams which traverse this section of the prairies. A few low depressions occur which are not so rapidly drained as the more rolling areas, but they do not remain in a wet condition for any considerable length of time.

The greater part of the area of this soil is formed from the weathering of a compact, apparently massive calcareous clay, known as the Taylor marl formation. Smaller areas also occur, which owe their origin to material derived through decomposition either from a soft chalky limestone or from the marly clays of the Eagle Ford formation. These clay marls and soft limestones weather rapidly to a great depth, forming a deep black clay soil.

The Houston black clay is well adapted to general farming and produces excellent yields of all the crops cultivated in the area. Oats and wheat produce larger yields than on any of the lighter-textured soils, and a very profitable yield of corn is almost always secured. The stiff clay subsoil enables this type to conserve enough moisture for the maturing of the crops grown, and they suffer less from drought or hot winds than those cultivated on the sandy soils.

Throughout the area occupied by this soil occur small areas on which potatoes, cotton, and fruit trees are seriously damaged and usually die. This is thought to be due to a fungus disease, mentioned later in this report.

The Houston black clay is considered best adapted to cotton and grain. A few vegetables are grown for home use, but the soil is not well adapted to orchards, small fruits, or vegetables. The yield of cotton, when not injured by the boll weevil, averages about one-half bale per acre. A larger yield is frequently obtained in particularly favorable seasons, and some farms on this type of soil have, with careful management, continuously produced a yield of three-fourths of a bale per acre. Corn gives an average yield of 30 to 35 bushels, but larger yields are secured in a wet season. Wheat averages about 15 bushels per acre, but is not extensively grown. The yield of oats, considered a sure crop, is seldom less than 35 to 40 bushels, and often more than 50 bushels. Barley and rye are also grown to a very limited extent and very fair yields are obtained.

The following table gives the average results of mechanical analyses of this type of soil:

Mechanical analyses of Houston black clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12883, 12887.......	Soil	0.2	1.3	1.7	7.9	10.0	46.5	32.0
12884, 12888.......	Subsoil.....	.1	1.0	1.5	7.6	9.0	45.7	35.1

YAZOO CLAY.

The Yazoo clay consists of a dark-brown clay loam, having an average depth of 8 to 10 inches. On drying, the surface cracks and the thin baked crust formed has a lighter color than that of the cultivated areas. This soil grades at about 10 inches into a very heavy dark-drab clay loam which rapidly becomes stiffer and heavier as the depth increases, until at 30 to 36 inches it is usually a stiff, dark-drab, tenacious, silty clay.

The type occurs along the valleys of the North and South forks of the Bosque River, and reaches the greatest extent between the junction of these streams and the mouth of the river. The topography is comparatively level, but low ridges, shallow depressions, and gentle swales give it a gently undulating character; the whole valley, however, has a general slope toward the stream. The greater proportion of the type is not at present subject to overflow, and the valleys, with the exception of the small, basinlike depressions, are well drained.

The Yazoo clay is of alluvial origin, being derived from material deposited along the valleys of the small rivers before the streams had cut their channels down to their present level. A large amount of material has also been washed down to these bottom lands from the high, rolling uplands which border them. The texture of the soil along the immediate banks of the streams is sometimes slightly sandier than the main body of the type, a condition due to the deposition of coarser material by the swifter currents during overflows. The area of this type, occupying the river valley at Valley Mills, has scattered over it low sandy ridges, too small to indicate on a map of the scale used, and the sand content of the surface soil in this section of the river valley is to some extent greater than in the typical areas.

The Yazoo clay is one of the strongest and most productive soils mapped in the area and well adapted to a great diversity of crops. A large yield of all those crops grown on the heavy upland soils is always obtained on this type, and truck, alfalfa, sorghum, and millet are successfully produced. The average yields of the important crops given below are based on the estimates of planters having this type of soil. Cotton yields from one-third to one-half bale per acre, and before the crop was annually damaged by the boll weevil a considerably higher average was maintained. Corn yields from 35 to 40 bushels, and oats from 40 to 50 bushels per acre. Very little wheat is grown, but it is estimated to give an average yield of from 12 to 15 bushels per acre. Alfalfa does exceedingly well, and from three to four cuttings are always secured. Onions and potatoes are grown for the local markets with excellent results. Large yields are also obtained from millet and sorghum, which are extensively grown for feed.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Yazoo clay:

Mechanical analyses of Yazoo clay.

Nnmber.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12909, 12911	Soil	0.2	0.5	0.4	4.4	8.8	48.6	36.8
12910, 12912	Subsoil	.0	.2	.4	3.5	7.7	49.3	38.9

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12910, 32.30 per cent; No. 12911, 82.71 per cent; No. 12912, 32.45 per cent.

YAZOO HEAVY CLAY.

The Yazoo heavy clay consists of a very heavy dark-drab to black clay, having an average depth of about 10 inches and grading into a subsoil of slightly lighter color, but stiffer and more tenacious structure. The subsoil gets heavier as the depth increases, and at 36 inches it is a drab to dark slate-colored, stiff, tenacious clay. Where properly cultivated the surface breaks up into a loose loamy soil, but if plowed when in a wet condition the clods become hard and baked, making it very difficult to get the soil into a condition suitable for the cultivation of crops and lessening its productivity in no small degree. When not under cultivation, or in areas where the drainage is poor, the surface upon drying becomes baked and sun cracked and has a lighter color than that of the cultivated areas.

The largest area of this type of soil occupies the broad flat valley of Tehuacan Creek, which traverses the eastern part of the area and extends some distance up the valleys of the principal tributaries. A second area of considerable extent occurs in the low bottom lands along the course of Aquilla Creek in the north-central part of the area. The narrow areas extending up the valleys of the smaller streams are not as subject to overflow as those along the large creeks, and they are usually of a lighter color. The opposite is true of the small, poorly drained depressions that often occur in the larger areas. The water collects in these depressions after heavy rains or overflows, and the sediment deposited, together with a large accumulation of organic matter, has formed a black clay soil of a stiffer character than that occupying the better drained areas.

The topography of these bottom lands is comparatively level. The gentle swells and ridges are low and rounded and the depressions are shallow and of small extent. The greater proportion of the type has a sufficient elevation above the level of the neighboring stream to cause it to be well drained, but ditching or tiling would greatly increase the agricultural value of some of the lower lying areas.

The Yazoo heavy clay is an alluvial soil, being composed partly of material deposited during overflows in the bottom lands bordering the large streams and partly of material washed down from the neighboring uplands during times of excessive rain. The larger streams overflow their banks and flood the broad flat valley lands about once in every three or four years. The finer material, composing the upland prairie soils, is taken in suspension by the small streams and deposited during overflows over the flooded areas adjacent to the larger stream courses.

The Yazoo heavy clay is very productive and with careful management gives large yields of cotton, corn, oats, and forage crops. Wheat is seldom grown and oats only to a limited extent, corn and cotton being the principal crops cultivated. The yield of cotton is annually greatly reduced by the boll weevil, as this crop is usually injured to a greater extent on these bottom lands than on the prairie. Before the advent of the boll weevil a yield of from two-thirds to 1 bale per acre was always expected, but at present the average yield is about one-half bale per acre. Corn gives an average yield of from 35 to 40 bushels per acre and is seldom a failure even in dry seasons. The yield of oats, a crop frequently grown, is about 35 or 40 bushels per acre. The fact that these lands are subject to overflow during the spring months makes the production of wheat uncertain and it is seldom grown.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Yazoo heavy clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12913, 12915	Soil	0.0	1.6	1.1	5.3	5.9	34.2	51.9
12914, 12916	Subsoil	.0	.3	.4	3.6	8.9	39.4	47.2

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12913, 5.93 per cent; No. 12914, 2.68 per cent; No. 12915, 1.87 per cent; No. 12916, 4.85 per cent.

MILLER FINE SAND.

The Miller fine sand consists of a loose gray to white, fine to medium sand, which grades at 12 to 15 inches into a sand of about the same texture, but of a slightly yellow or brown color, and extending to a depth of from 4 to more than 6 feet.

The Miller fine sand occurs in small hillocks, covering only a few square yards throughout the valley of the Brazos River, but the largest area occupies a ridge on the eastern side of the Brazos in the northern part of the area surveyed. A ridge of this type, seldom more than a few rods wide, is sometimes found bordering the banks of the river. These areas often have the general appearance of low sand dunes and, with the exception of the narrow strip along the river banks, they are mainly of wind-blown origin, the strong winds causing the fine sand of the Miller fine sandy loam to drift into the small sand mounds which finally cover the underlying alluvial material to a depth of many feet.

The largest area north of Gholson is not cultivated to any extent and is of small agricultural value. However, cotton and corn are sometimes grown on limited areas, and these crops in a wet season give fair yields. The small sand mounds, associated with the Miller fine sandy loam, are cultivated, but where the sand reaches any great depth they are of small agricultural value.

The following table gives the results of mechanical analyses of samples of this soil type:

Mechanical analyses of Miller fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12858	Soil	0.0	0.9	7.1	66.7	22.8	1.0	1.4
12859	Subsoil	.0	1.6	13.2	62.7	18.3	2.0	2.0

SUSQUEHANNA FINE SANDY LOAM.

The soil of the Susquehanna fine sandy loam is a gray to very light-brown fine sandy loam, having an average depth of from 10 to 12 inches. A few small rounded gravel are frequently encountered, scattered on the surface and mixed with the soil. The subsoil consists of heavy sandy clay of a red to reddish-brown color, also containing an occasional waterworn pebble. This subsoil rapidly becomes stiffer and the depth increases until at 36 inches it is a stiff, slightly mottled clay, though still containing a perceptible quantity of sand.

Small areas of this type are often encountered where the underlying subsoil ranges from a yellowish-brown to drab-colored sandy clay. Other small areas occur, scattered over the territory embraced by this type, which contain a larger percentage of rounded gravel and small pebbles than is found in the greater proportion of the soil. Where the gravel content is of sufficient importance to warrant, and the areas are large enough to be shown on a map of the scale used, the soil has been given a separate classification.

The largest areas of the Susquehanna fine sandy loam are scattered over that section of the area surveyed which lies east of the Brazos River. Other small detached areas are encountered on the west side of the Brazos, but they cover no great extent of territory. The larger areas are usually found at no great distance from the valley of the Brazos and their trend is northwest to southeast, with the general direction of the river.

The topography of the Susquehanna fine sandy loam is rolling. The hills are low and rounded, but the valleys between them are usually narrower than those of the rolling prairies, and the small streams, which flow through them, frequently cut out deep erosions. The hillsides are seldom steep, but the soil is easily eroded and small areas are often encountered along the steeper slopes where the sandy soil has been washed off, leaving the underlying sandy clay exposed on the surface. The topography of the areas of Susquehanna fine sandy loam, situated east of Elm Mott, is slightly more broken than that of the greater part of this type. The hills are somewhat steeper and the country is intersected by numerous small streams which have their source in this section of the area.

The rolling topography and sandy character of the soil itself insures excellent drainage, which in the more rolling sections is often too thorough for the best results to be obtained from the crops cultivated.

The fine sand and sandy clays from which this soil is formed are the remains of an old deposit which was laid down over the older geological formations which underlie this part of the area. The rounded, waterworn gravel that occurs in both soil and subsoil indicates that this material was deposited by water. This soil represents the southern extension of the "Lower cross timbers."

A comparatively small proportion of the Susquehanna fine sandy loam is under cultivation, the remainder being at present covered by a heavy growth of post oak. The soil itself is locally known as "post-oak land" and is not considered a very strong soil for general farming purposes. The crops cultivated usually suffer for want of sufficient moisture in a season of average rainfall and are, as a rule, a failure during a dry season. In a wet season, however, very profitable yields are always obtained. The soil warms up early in the spring and can be cultivated sooner after heavy rains than the other upland soils. It is better adapted to crops which mature before the hot, dry months of late summer. Peaches, plums, and pears do well on this type, and it is also well suited to the production of small fruits. Wheat is not grown, and oats to a very limited extent, yielding about 25 bushels per acre in a season of average rainfall, though larger yields are secured in a wet season. Cotton gives an average yield of one-quarter bale per acre, and one-half bale per acre is sometimes produced, but this is considered a large yield. Corn averages about 20 bushels per acre during an ordinary season, but, as with oats, a much larger yield is secured in a wet year. In dry seasons the crop is usually a failure. Vegetables do fairly well and are grown to a limited extent for the local markets.

The following table gives the average results of mechanical analyses of samples of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12860, 12862	Soil	0.6	4.7	8.1	29.9	22.2	25.0	9.3
12861, 12863	Subsoil.....	.6	3.5	5.3	18.0	11.9	22.6	38.0

MILLER FINE SANDY LOAM.

The Miller fine sandy loam possesses a mellow, friable, easily tilled surface soil with a depth varying from 12 to 24 inches. It is made up largely of fine to very fine sand and silt of a brown or grayish-brown color, the lighter color being more noticeable when the soil is in a dry condition. The soil grades within a few inches, at the point of contact with the subsoil, into a red, sticky, sandy clay, which usually becomes slightly heavier with increase in depth. The subsoil is composed of nearly equal parts of clay, silt, fine sand, and very fine sand.

Along the edge of some of the terraces erosion has removed the sandy soil covering, leaving exposed the red clayey subsoil. One phase of this type consists of sandy soil, 3 feet or more in depth, the clayey subsoil being either lacking or buried so deep as to have no influence on the surface conditions. This phase occurs near the river and reaches the greatest development in the vicinity of Tehuacan Creek. Other local areas of this phase, situated farther away from the river, can be attributed to wind-blown sand. There are also areas of limited extent where the sand approaches a medium to coarse texture, and still others where the silt content of the soil is greater and the subsoil is heavier and darker in color. These phases are so limited in extent and so intimately associated with the typical soil that it was found impracticable to map and classify them as separate types of soil.

The Miller fine sandy loam is found only along the Brazos River and is the principal bottom type of the area. It occurs on both sides of the river and extends entirely across the area. The main bodies of it are found in the bends of the river, the largest on the east side of the river opposite the city of Waco and on the west side below Patrick.

The surface of the Miller fine sandy loam is terraced and each terrace is nearly level. The terrace nearest the river is but little above the river bed and is quite frequently overflowed. Back from the river on the big bends there is a succession of terraces, varying in width, each rising to a height of several feet above the last. These higher terraces are never or rarely inundated.

The texture of the surface soil of the Miller fine sandy loam is such that it can be worked much sooner after a rain than any soil of the area except the Miller fine sand. Water falling on the surface is quickly absorbed and removed to the lower depths away from the excessive evaporation at the surface, although the subsoil is heavy enough to prevent its going beyond the reach of capillary attraction. The whole soil is of such a texture and structure that a large percentage of the rainfall is conserved. The surface streams are all small and play no great part in the drainage of the type; yet it is well drained except in a few local low spots which could be easily drained either by open or tile drains extending to the lower terraces.

The Miller fine sandy loam is a deposit laid down by the Brazos River in times of flood and belongs to the present geological time. Along the lower terraces, which are overflowed, it is still in the process of formation. The higher terraces were probably formed when the bed of the river was higher than at present. The red color is due to the fact that the materials deposited are derived from the Permian red beds farther inland.

The Miller fine sandy loam seems to be well adapted to the growing of garden truck, such as radishes, lettuce, cabbage, onions, tomatoes, beets, Irish potatoes, etc. It warms up early in the spring and is easily worked while the clay soils are yet too wet to be handled. These crops grow rapidly, are easily cultivated, and of an excellent quality. Peaches, pears, plums, blackberries, etc., also do especially well on these bottoms. With the shipping facilities afforded, in addition to the good local markets, the acreage of these crops could safely be increased in the vicinity of Waco. Farther up the river the distance from shipping points would be a serious drawback. The advent of the boll weevil has made these bottoms less valuable for cotton, and a further development of the fruit and truck industries, for which this soil is so well adapted, would be in line with the idea of diversification expressed in another part of this report.

Cotton is the chief crop grown at present on the Miller fine sandy loam and yields from one-third to two-thirds bale per acre. The yield has been very materially affected by the boll weevil—more so than on any other soil of the vicinity. Prior to the advent of this troublesome pest the farmer was sure of making from three-fourths bale to 1 bale per acre, but now he may make a good crop or it may be a total failure. Considering the success of the fruit and truck industries already mentioned it would seem to be wise to increase the acreage devoted to these crops and to plant less cotton. Corn does not seem to do as well on this soil as on some others, yet in favorable seasons it yields from 50 to 60 bushels per acre. The average, however, is very much lower, being about 20 bushels on the poorest tracts and 35 bushels on the best. The corn crop is almost a total failure about one year out of eight, owing to the blasting effects of hot dry winds that sometimes occur just before it matures.

Alfalfa has been successfully grown in the last few years, and the acreage is being gradually increased. It is somewhat difficult to secure a good stand, but when once established three cuttings are obtained each season, each yielding about 1½ tons per acre. The best stand is secured when the seeding is done in October or November.

There are about 500 to 600 acres of peaches and other small fruits in bearing in the vicinity of Waco, the largest part of the orchards being located on the Miller fine sandy loam. These fruits are not often affected by frosts and good crops are usually secured each alternate year. The Mamie Ross peach is earliest, being ready for market about the middle of June, followed about three weeks later by the Elberta. Peach trees are set 18 feet by 20 feet apart and yield from 1½ bushels to 2 bushels per tree. The trees are said to remain in bearing for 10 or 12 years before becoming exhausted. Insect pests are noticeably absent, except the codling moth, which attacks the pear to some extent.

So far the truck crops produced have been grown for the local market and do exceedingly well. Irrigation is used to some extent for the fruits, alfalfa, and truck, the water for this purpose being secured from artesian wells.

The following table gives the average results of mechanical analyses of samples of this type of soil:

Mechanical analyses of Miller fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12380, 12907.......	Soil	0.2	3.8	7.0	37.1	18.5	24.8	8.4
12381, 12908.......	Subsoil.....	.3	2.4	5.5	27.2	17.4	21.6	25.2

TRAVIS GRAVELLY LOAM.

The surface soil of the Travis gravelly loam, to a depth of about 10 inches, consists of a medium to fine sand or sandy loam, gray or grayish-brown in color, carrying a high percentage of small rounded gravel of various sizes. The subsoil, extending from 10 to 36 inches, is a mass of coarse sand and small rounded gravel, like that in the soil, imbedded in a matrix of heavy, stiff red clay. Sometimes the gravel occurs in such quantity as to form a veritable gravel bed and again the percentage is quite small.

The largest body of this soil lies east of Elm Creek, extending from the northern border of the area to the vicinity of the mouth of Whiterock Creek. Another area of considerable size is found east of

Whiterock Creek at Ross. Between Aquilla and Elm creeks there is also an irregular-shaped area, and a small body occurs on the boundary north of a big bend in Aquilla Creek.

The topography is undulating to quite rolling, but not rough enough to hinder cultivation, except perhaps on a few of the steeper hillsides. This rolling surface gives the greater part of the type excellent natural drainage. There are a few depressed areas in the vicinity of Ross, which are not nearly as well drained. In these surface water collects and has no way to escape except by seepage. The texture of the clay subsoil is such that this process is necessarily slow, and as a result these areas are covered with stagnant water, except in dry times, and are consequently unfit for cultivation. The soil of these wet depressions is more loamy and the gravel content is comparatively small. They could be drained by cutting open ditches through the slight elevations surrounding them and would then make a strong soil for farm purposes.

The gravel present indicates a condition of flood and swift current at the time of the deposition of the material forming this soil. It is derived from an ancient alluvial deposit which covers a considerable proportion of the uplands in this part of the area.

The Travis gravelly loam is adapted to the production of peaches, plums, pears, berries, etc. Vegetables can also be grown to advantage. The fruit trees flourish and yield well. The stiff, impervious character of the subsoil prevents leaching, and the light sandy surface soil warms up early in the spring. Very little of this soil has been cleared and brought under cultivation, the greater part of it being still covered by the original forest growth, mainly post oak.

The Travis gravelly loam produces much better crops than one would naturally expect from its appearance. Cotton has yielded as high as one-half bale or more per acre and will average one-third of a bale from year to year. Corn does fairly well, yielding from 20 to 25 bushels per acre. Oats yield from 35 to 40 bushels and wheat about 10 to 15 bushels. All of these crops do much better in a wet season, and the yields often equal those of the "black land" in a dry season. "Gall spots" occur to a very limited extent, in which cotton, potatoes, and fruit trees die out. These are more noticeable during wet seasons.

The following table gives the average results of mechanical analyses of samples of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Travis gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12899, 12903	Soil	11.4	18.1	13.0	21.6	15.8	14.4	5.6
12900, 12904	Subsoil	9.0	14.8	14.8	16.2	6.5	7.9	30.7

HOUSTON CLAY.

The Houston clay is a dark-brown to black clay, with an average depth of about 10 inches. The color varies somewhat with the topographic position. The darker colored areas occupy the shallow depressions and more level areas, while the color of the soil occurring on the slopes is usually of a lighter shade. The surface is friable and easily cultivated, but it becomes baked and sun cracked in areas not under cultivation.

At about 10 inches the soil grades into a stiff clay subsoil, of somewhat lighter color, and containing small fragments of decomposed limestone. At a depth of from 25 to 36 inches the stiff clay becomes considerably lighter in color and passes gradually into a soft white mass of rotten limestone or chalk, which always underlies this soil at no great depth. The upper part of this chalky limestone has decomposed to such an extent that it forms a soft white mass of chalky material easily crumbled between the fingers, and the transition of the overlying clay into this material is so gradual that there is no distinct line of contact.

On many of the steeper slopes extensive erosion has taken place and small fragments of limestone frequently occur scattered over the surface and mixed with the soil. The soil on these areas is shallow and small patches occur where the soft, chalky material of the lower subsoil has been turned up with the plow, causing the surface to have a white or grayish color. In the shallow depressions the soil is deep and black, owing to the washing in of material from the neighboring slopes. Here the underlying limestone is frequently many feet below the surface, and the subsoil is stiffer and of a darker color.. Where these areas are of sufficient extent they have been classed with the Houston black clay.

The main body of the Houston clay occurs in a strip extending from the Brazos River, north of Waco, in a southwest direction to the southern boundary of the area. Other patches occur on the east side of the Brazos in the northeastern part of the area, but they are of no great extent.

The topography of the greater part of this type is rolling, but the hills are rounded and the intervening depressions are broad and shallow. Along the smaller streams, however, the topography becomes more broken and the hillsides are steep and eroded. The shallow valleys of the rolling section gradually get narrower as the western boundary of the escarpment occupied by this soil is approached, and the small streams in this section have cut out deep gorges, which extend from the rolling uplands to the valley of the Bosque River.

The Houston clay is well drained, as the rolling character of the topography causes water to find its way rapidly to the small streams.

The steeper slopes and higher elevations are often excessively drained. The water seeping through the heavy subsoil is absorbed by the soft, rotten limestone and crops are often seriously damaged by drought.

The Austin chalk, previously mentioned as forming the escarpment which extends across the area, weathers rapidly to a considerable depth and forms by its disintegration the material which composes this soil. The rock first breaks up into thin, shaly fragments which decompose into the soft, white mass of chalky material which is found in the lower depths of the subsoil. On the eastern side of the Brazos River that portion of the Austin chalk escarpment which lies within the area surveyed is covered to varying depths by the old alluvial deposits, and the Houston clay only occurs in small areas where the overlying deposit has been removed by erosion.

Cotton usually matures considerably earlier on the Houston clay than on the Houston black clay, and the crop is seldom as seriously damaged by the boll weevil as on the other heavy clay soils. The average yield ranges from one-fourth to one-third bale per acre. The better yields of corn are obtained in wet seasons, but the average under ordinary conditions lies between 20 and 25 bushels per acre. With oats a yield of 35 to 40 bushels per acre is continuously obtained. Wheat averages about 10 bushels per acre, but is not extensively grown. Millet and sorghum cane are grown to some extent and profitable yields are always secured. The Houston clay in a wet season often produces yields of these crops which compare very favorably with those obtained from the Houston black clay, but drought affects it to a much greater extent.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Houston clay:

Mechanical analyses of Houston clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12854, 12856	Soil	0.3	1.4	1.3	4.3	7.0	39.3	46.4
12855, 12857	Subsoil	.5	1.6	1.2	4.2	6.2	33.6	52.5

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12854, 25.8 per cent; No. 12855, 47.5 per cent; No. 12856, 33.1 per cent; No. 12857, 49.55 per cent.

HOUSTON GRAVELLY CLAY.

The Houston gravelly clay is a heavy dark-drab or black clay loam containing a large quantity of small rounded gravel, varying in size from coarse sand to pebbles 2 or 3 inches in diameter. The coarse sand present with the gravel seldom makes any material difference in the sticky nature of the soil. At 10 inches below the surface the gravel content is much lower and the subsoil becomes a stiff dark-drab to dark-brown clay, containing a little gravel.

This soil is of very limited extent and occurs in the vicinity of Elm Mott and Ross. There is also a narrow strip on the east side of Tehuacan Creek. It occurs as a rule capping the low swells or elevations in the Houston black clay, and this physiographic position gives it good natural drainage. The origin of the Houston gravelly clay is traced to the remnants of an old gravel formation which once covered this entire region. The material of this deposit has been more or less intermingled with the materials forming the Houston black clay, which it overlies.

Crops on the Houston gravelly clay do not yield as well as those grown on the Houston black clay or "black land." Wheat is seldom sown. Oats are a surer crop than corn, and yield about 30 bushels per acre, always doing best when sown in the fall. Corn will average 20 bushels per acre, but is often a total failure. Cotton will not average more than one-fourth bale per acre. Sorghum cane is grown for feed and does well. The effect of drought is much more marked on this type than it is on the heavier "black land."

The following table gives the results of mechanical analyses of the fine earth of the soil and subsoil of the Houston gravelly clay:

Mechanical analyses of Houston gravelly clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12889	Soil	1.9	5.2	7.7	15.8	16.8	30.8	21.8
12890	Subsoil	1.4	3.9	5.1	10.6	10.8	22.1	45.9

HOUSTON LOAM.

The typical soil of the Houston loam is a gray to light-brown loam, from 10 to 12 inches deep, and containing a large amount of silt. The surface is friable, and when well cultivated the soil has a very desirable tilth. At about 12 inches the soil grades into a drab to slate-colored silty clay, which also contains a considerable amount of fine sand. This subsoil becomes heavier as the depth increases, and at 36 inches it is a stiff, plastic, silty clay, often slightly mottled and still containing a small percentage of fine sand. Small rounded pebbles are sometimes encountered in both the soil and subsoil.

The Houston loam occurs in irregular shaped areas of varying extent in the northeastern part of the area surveyed, and smaller patches are found in other localities where conditions favorable to its formation exist. The topography is gently rolling, and the general appearance of these areas is that of a slightly rolling upland prairie. The drainage of the greater proportion of the type is good, but small poorly drained depressions sometimes occur, where water collects after rains. These areas are usually found in the more level sections of the uplands, and have a sufficient elevation above the level of the small streams and shallow valleys to permit their being easily drained by means of open ditches.

The Houston loam usually occurs in areas bordering the heavy black clay lands and the lighter alluvial soils, and is composed of the material which forms these two opposite types of soil. The areas bordering the light sandy soils contain the larger quantities of sand, while along the contact with the black clay soil the texture is heavier. A considerable proportion of the sand content of this soil is derived from the fine sand of the Susquehanna fine sandy loam which has been transported by the wind and laid down over the surface of these areas. On some of the small ridges the sand content is greater than that of the typical soil. This is due to the larger amount of material transported by the wind from adjacent areas of fine sandy loam. However, the greater part of the material forming the type consists of a combination of a fine sandy alluvial deposit and the heavier material composing the black prairie soil.

The Houston loam is better adapted to early maturing crops, as the droughts of the late summer months seriously affect the yields. Cotton, up to the present season (1905), has never been seriously damaged by the boll weevil and produces an average yield of one-third to one-half bale per acre. Corn yields about 25 bushels per acre in an ordinary season, oats about 35 bushels per acre, and wheat, rarely grown, from 10 to 12 bushels per acre. Sorghum cane is grown as a forage crop with good results, and alfalfa has also been grown to a limited extent, but great difficulty is usually experienced in getting a stand. In general the crops cultivated on this type are subject to serious damage from droughts, but during a favorable season very fair yields are always obtained.

The following table gives the average results of mechanical analyses of the fine earth of this soil:

Mechanical analyses of Houston loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12877, 12879	Soil	Tr.	1.4	3.0	14.8	17.1	40.0	23.4
12878, 12880	Subsoil	0.2	1.4	2.0	10.5	11.8	37.4	36.6

The following sample contains more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12878, 2.01 per cent.

CRAWFORD CLAY.

The Crawford clay is one of the most important types found in the Waco area. The soil averages 8 or 10 inches in depth and consists of a brown, slightly reddish clay, which is stiff and tenacious when wet but friable and granular when in a dry well-cultivated condition.

The subsoil, extending from 10 to 36 inches, is a stiff, tenacious clay of a lighter reddish-brown color, which becomes stiffer and more compact as the depth increases and often contains small fragments of limestone in the lower part of the 3-foot section. The depth to the parent rock ranges from 3 to 6 or 8 feet, the deeper areas occupying slight depressions.

This soil is very uniform in color and texture throughout the whole area embraced by it, the only variation being in the depth to the underlying limestone, and this is largely influenced by topographic position.

The Crawford clay occurs in large unbroken areas occupying almost all the gently rolling and more level sections of the prairie in the western half of the area surveyed. The whole prairie section occupied by the type is a gently rolling upland plateau, which reaches its greatest altitude in the northwest part of the area and has a general slope toward the east. In the western part of the area this plateau has a considerable elevation above the level of the small streams and rivers which traverse it, and the streams flow through deep narrow gorges with almost perpendicular limestone walls. In the eastern part of this prairie section the general elevation is not so great and the stream valleys are not so steep or so narrow. A few of the rounded hills in the northwestern part of the area reach an altitude of more than 700 feet, and the prairies often slope rather abruptly toward the small streams, but where the slopes are steep enough to cause the soil to suffer to any extent from the effect of erosion they are occupied by the Crawford stony clay.

The position of this type on the rolling upland plateau, at a considerable elevation above the level of the small streams, causes it to be excellently drained, yet the stiff character of the subsoil enables it to conserve enough moisture during a season of average rainfall for the successful production of all the crops grown.

The soil owes its origin to the decomposition of the Fort Worth limestone, composed of a series of hard white limestone strata separated by thin layers of marly clay. The harder strata weather more slowly than the marly material, and this, together with the effects of erosion, causes the depth of the soil to vary considerably at short intervals along some of the slightly terraced hillsides.

A large proportion of the grain produced in the area is grown on this soil, and it is considered well adapted to both wheat and oats. The season affects these crops to some extent, but in an ordinary year wheat will produce on an average 15 bushels per acre and oats from 30 to 40 bushels per acre. If there is an unusually large rainfall the wheat crop is often seriously damaged by rust, and, on the other hand, if the season is very dry this causes a decrease in the yield, but as a rule very profitable yields of both wheat and oats are secured. In like manner the yield of corn varies with the rainfall during the growing season. The crop is seldom a failure and will average from 15 to 20 bushels per acre in a dry year, rising from this to a yield of from 30 to 40 bushels during wet seasons. The boll weevil, up to the present time, has not damaged the cotton crop of this section of the area to any great extent, although a small part of the crop is destroyed annually. Cotton produces on an average a yield of one-third bale per acre, but where well cultivated yields of three-fourths to one bale per acre have often been obtained in favorable seasons. Millet and sorghum cane are grown for feed purposes. Sorghum produces about 2 tons per acre, and two cuttings are frequently secured. The yield from the second cutting is not so large, but the cane produced is of a lighter growth and makes a better feed for stock. Rye is grown to a limited extent and gives an average yield of 20 bushels per acre. A small part of the crop grown is not thrashed, but is used for feed purposes. Peaches and plums are successfully grown, but the trees seldom produce after they are 5 years old.

The following table gives the average results of mechanical analyses of the Crawford clay:

Mechanical analyses of Crawford clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12870, 12872.......	Soil	0.2	1.1	1.1	6.6	9.2	49.6	32.0
12871, 12873.......	Subsoil.....	.1	.8	.9	6.3	9.2	46.3	36.0

The following sample contains more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12873, 5.26 per cent.

CRAWFORD STONY CLAY.

The Crawford stony clay is of little importance both in extent and in agricultural value. It consists of a dark reddish-brown clay, usually carrying a large number of limestone fragments of various sizes embedded in the soil and scattered over the surface. The soil is shallow, the underlying limestone occurring at depths varying from 12 to 20 inches. Many areas have a comparatively small quantity of rock fragments on the surface, but the underlying limestone is encountered at a slight depth and outcrops in small areas where erosion has been greatest. This soil occurs along the slopes adjacent to the small streams and larger draws in the rolling prairies of the western part of the area. It also occurs in the rougher and more broken country north and northeast of Valley Mills. The topography in this section of the area is very rolling, and the hills often have a terraced appearance. The hillsides extending to the small streams or draws are often steep and have only a shallow covering of soil overlying the hard white limestone strata.

The area embraced by the soil is well drained, as many small streams and deep draws occur in the valleys between the rolling hills. The soil is so shallow and stony that very little moisture is conserved, and this causes it to be of small value agriculturally.

The Crawford stony clay owes its origin to the weathering of the Fort Worth limestone, which underlies it at a slight depth, but owing to the general character of its topography the material forming the soil is rapidly eroded and is washed down to the more level areas, only a shallow stony covering of soil being left above the parent rock.

The areas covered by the type are not suited to cultivation, but they support an excellent growth of the native grasses and are used almost exclusively as pasture lands. The larger cattle ranches are located in this section of the area; and as it is well watered by many small perennial streams and as the shallow soil produces an abundance of grass, it is well adapted to this industry.

Small areas that are comparatively free from stones are sometimes cultivated; and if there is an abundance of rainfall during the growing season, a fair crop is secured. The average yields on these cultivated areas, when the crops are not destroyed by drought, are as follows: Corn, 15 bushels per acre; wheat, about 6 bushels per acre; oats, 20 bushels per acre, and cotton from one-sixth to one-fifth bale per acre. Sorghum is often cultivated, and although no very large yields are obtained, a thin growth well suited for feeding purposes is produced.

CRAWFORD LOAM.

The soil of the Crawford loam, to an average depth of 12 inches, is a brown to reddish-brown loam, containing a relatively large percentage of silt and fine sand. The surface usually contains the largest proportion of sand and often has the general appearance of a fine sandy loam. At about 12 inches below the surface the material becomes noticeably heavier and consists of a heavy brown loam. This grades at 20 to 25 inches into a stiff, compact clay, redder in color, still containing a relatively large quantity of fine sand. The soil occurs mainly in one unbroken area situated north of the Bosque River and southeast of China Spring. A few detached areas occur along the North Fork of Bosque River, but these are very small.

The topography is rolling, but is never of so rough a character as to cause serious erosion of the soil or to interfere with cultivation. This type is well drained by many small intermittent streams which extend from the shallow valleys between the low elevations to the North Fork of the Bosque River. Crops are more apt to suffer from drought than from the lack of sufficient drainage. The light, loamy texture of this soil makes it easy to cultivate, and it can be worked very shortly after heavy rains without impairing its naturally good mechanical condition.

There is a phase of this type on the summits of the low ridges. The sand content of the surface is often higher than is usually found in the main body of the soil type, but these areas are of very small extent and the texture of the whole 3-foot section is only a slight degree lighter than that of the typical soil.

The Crawford loam is residual and is formed from the weathering of the sandy ferruginous clays, impure limestone, and sandstone which compose the underlying geological formation. A few fragments of sandstone are encountered on the surface of some of the higher ridges, but the heavier subsoil and a large proportion of the soil are probably derived mainly from the reddish sandy clays and from the impure limestone.

This soil is well suited to the cultivation of cotton, corn, and fruits and also produces very fair yields of wheat and oats. Several small orchards of peaches and plums are located on the Crawford loam and annually produce very profitable crops, and fruit growing bids fair to become an important industry in this part of the area. Small fruits also do well. Vegetables are successfully grown for home use and on a small scale for the local markets. With the cultural methods in general use, cotton produces one-third bale per acre, but when more care is taken one-half bale per acre has been secured year after year, and in a favorable season, when the crop is not attacked by the boll weevil, 1 bale per acre has often been produced on this soil. Corn usually yields from 20 to 30 bushels per acre and wheat 10 to 15 bushels per acre. Millet is grown for feed purposes and produces about 1½ tons per acre. Sorghum is sown broadcast and cut for feed and does exceedingly well on this type of soil.

The following table gives the average results of mechanical analyses of typical samples of this soil:

Mechanical analyses of Crawford loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12866, 12868	Soil	0.1	1.3	2.9	22.2	21.6	31.5	20.1
12867, 12869	Subsoil	.1	.8	2.4	17.0	16.3	38.3	24.5

MILLER HEAVY CLAY.

The soil of the Miller heavy clay, to a depth of 8 or 10 inches, is a brown or reddish-brown clay, stiff and tenacious when wet and baking and cracking on drying. Hard, bricklike clods are formed if it is plowed when in a wet condition. This surface soil grades into a stiff clay subsoil, lighter and of a more pronounced reddish color. In the lower part of the 3-foot section the subsoil often contains a larger percentage of silt, and from 25 to 36 inches it is usually a stiff, plastic silty clay of a reddish-brown color. Both the soil and subsoil are very heavy clays containing very little sand, but if cultivated properly the surface breaks up into a loose loamy soil, free from hard clods and having a very desirable tilth. The color of this soil is usually redder along the banks of the streams, and as the distance from the streams increases it grades through a darker brown color into the black Yazoo heavy clay which occurs farther up the valleys.

The Miller heavy clay occurs chiefly in the bottom lands of Tehuacan and Aquilla creeks and extends a short distance up the stream valleys. Other smaller areas occupy low river terraces on the western side of the Brazos River southeast of Waco.

The typography, like that of the upper portion of the valleys, is almost level, but slight elevations and shallow depressions occur at intervals and the surface as a whole has a gentle slope toward the stream. Although these lands are sometimes overflowed they seldom remain in a wet condition for any great length of time. Some of the shallow depressions are poorly drained and would be greatly improved by artificial drainage, but the topography and position of the type in general enables the small streams rapidly to carry off the excess water after floods or heavy rains.

The Miller heavy clay is an alluvial soil and owes its origin to material deposited by the Brazos River, combined with the fine material brought down from the upland prairies by the smaller streams. At times of overflow the flood waters of the Brazos River back up the channels of the smaller streams and spread out over the low, flat valleys. The fine red-colored silt and clay held in suspension by the river water is deposited over these bottoms, and becoming mixed with the darker colored material brought down from the black prairie region by the smaller streams forms a stiff reddish-brown clay.

This soil is well adapted to cotton, corn, and oats, and very profitable yields are usually secured. The yield of cotton, like that obtained from the other lowland types, has been greatly reduced by the ravages of the boll weevil. The average yield is now about one-half bale per acre, although three-fourths bale per acre is often produced. Corn yields from 30 to 35 bushels per acre on the average, and in a favorable season a yield of more than 40 bushels is not uncommon. Forty bushels per acre is about the average yield of oats. No wheat is at present grown on this type. Sorghum cane is grown as a forage crop to a limited extent and does exceedingly well.

The following table gives the average results of mechanical analyses of typical samples of the Miller heavy clay:

Mechanical analyses of Miller heavy clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12895, 12897	Soil	0.1	0.8	0.6	1.8	1.2	35.8	59.6
12896, 12898	Subsoil	.0	.1	.3	1.3	1.6	41.0	55.7

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12895, 13.02 per cent; No. 12896, 21.80 per cent; No. 12897, 8.59 per cent.

MILLER SILT LOAM.

The Miller silt loam consists of a fine-grained silt loam, with a depth of about 15 inches, containing a relatively large percentage of fine and very fine sand. Its color, like that of the other bottom soils associated with it, is brown. The texture becomes slightly heavier as the depth increases, and the material grades into a subsoil somewhat darker in color and heavier, which, however, still carries an appreciable amount of fine and very fine sand. Both soil and subsoil are usually tinged with red. The soil becomes hard and compact, and cracks slightly when dry, but breaks up into a mellow, easily tilled seed bed upon cultivation.

The extent of this type is inconsiderable, there being only a few small, irregular-shaped areas west of the river below Waco. It occupies river terraces and is high enough above the stream level to insure good drainage. The surface is nearly level to slightly undulating.

The origin of the Miller silt loam is similar to that of the Miller heavy clay and Miller fine sandy loam, namely, the deposition of sediments on the flood plain of the Brazos River, the red color being due to the origin of the material brought down.

A considerable part of the Miller silt loam is now used for Johnson grass for pasturage. Cotton, when well cultivated, yields from one-third to one-half bale per acre. Corn, which does well, yields, on the average, from 25 to 30 bushels per acre, oats from 30 to 40 bushels, and wheat from 12 to 15 bushels per acre. Some alfalfa is grown and does well. Crops on this soil stand drought better than those on the more sandy soils, and it is considered a strong soil for general farming.

The following table gives the average results of mechanical analyses of samples of the Miller silt loam:

Mechanical analyses of Miller silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12891, 12893.......	Soil	0.0	0.3	0.2	5.4	22.6	53.7	17.4
12892, 12894.......	Subsoil.....	.0	.1	.3	7.2	24.5	50.5	17.1

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12891, 4.38 per cent; No. 12893, 4.85 per cent.

ROCK OUTCROP.

A few small areas occur along the steeper slopes where the soil has been entirely eroded away and the underlying rock is exposed on the surface. Where these areas are of sufficient extent they have been indicated on the map by means of the rock symbol.

AGRICULTURAL METHODS.

The agricultural practices of the Waco area are extensive rather than intensive. For cotton, on the sandy soils, the surface is usually listed, the plow running about 4 inches deep. Where the field has been in cotton the preceding year, the old row or bed is broken out by the lister. After the listing, the ridges or beds are smoothed, then opened, and the seed planted on the ridge by a single-row horse planter. This brings the rows midway between those of the previous year. The same method is used where cotton follows corn or corn follows cotton. When the cotton plants are well started the cotton is chopped out twice and then cultivated and plowed to keep down the weeds. The methods of handling the heavy soils are very much the same as for the sandy lands, except that the clays are more commonly prepared by using a turning plow, and the rotation of crops is more frequently practiced. These lands are usually plowed to a depth of about 4 inches in the late fall or winter and afterwards listed in preparation for planting. Where wheat or oats follow cotton the seed is drilled in without breaking of any kind, but for any crop the stubble land is usually broken. Some of the farmers in the vicinity of Crawford plant their cotton in the hollow instead of on the ridge, and as the plants grow the soil is thrown around them by cultivation until the surface is level or slightly ridged at the row. A remarkable characteristic of these heavy soils is the excellent tilth secured if they are worked when in proper condition, but if broken when too wet or too dry they break up into large, hard clods, and subsequent cultivation is difficult.

A deeper plowing should be practiced on all the soils and then followed by more thorough preparation for the seed and shallow cultivation to conserve the soil moisture during the growth of the crops. It is conceded by many of the planters that the chief reason for poor yields is, as a rule, poor preparation, cultivation, and management.

On the sandy soils practically no rotation is followed. Cotton is grown year after year, with an occasional crop of corn, but on the heavy soils a good many farmers are planting wheat after cotton and following wheat with corn. This rotation is most common in the western part of the area. It is said that on the sandy soils there are 40 acres of cotton to 10 acres of corn and scarcely any wheat, so that the systematic rotation of crops would not be practicable unless a change in relative acreages be made or some new crop or crops be introduced.

Cotton is generally planted in April and picking commences the last of August. The most of the crop, however, is not ready for picking until September or October. Corn is planted usually during the last of February and first of March and harvested the latter part of August. Oats and wheat are sown about October, but the former may be sown as late as January. The oats ripen in May and the wheat in June. The grain crops are more generally grown on the heavy limestone clays in the western part of the area.

Commercial fertilizers have not been used extensively, and on the clay soils are practically unknown. During the season of 1904 about 200 pounds per acre of acid phosphate and potash were applied to several plats on the sandy bottoms with excellent results. This season—1905—enough complete fertilizer has been sold for 1,000 acres at 200 pounds per acre, and the results attained from its use are awaited with interest.

Almost every farmer is supplied with the most improved machinery of the day. This consists of wheel plows, listers, planters, cultivators, etc. By means of these the farmer is enabled to plant and care for a large acreage with comparatively little help.

AGRICULTURAL CONDITIONS.

Until comparatively recent times the whole region about Waco was one vast open range and used almost exclusively for grazing purposes, but with the increase in population and the improvement of transportation facilities the cattle ranches gave way to the cotton fields, until now nearly all of the area surveyed is under cultivation and only a few large ranches still exist. These are in the northwestern part of the area, where the soils are too shallow and stony to permit of profitable cultivation.

The farmers of the area are at the present time in a fairly prosperous condition. During the past few years good crops have been obtained and the number of mortgages has greatly decreased. It now rarely happens that the farmer is unable to meet his debts.

The high price obtained for the cotton crop of 1903 has aided materially in enabling the farmers to stand the lower prices of the present season (1904–5), and a majority have been able to hold a large proportion of the crop until it could be marketed at a greater profit.

The farm buildings in the rolling prairie sections are usually neater and more modern than those found on the light, sandy uplands, and the farmer on the heavier soil is, as a rule, in a more prosperous condition. There are few large barns and extensive outbuildings, but the climate is so mild that the stock does not need to be housed during the winter, and as the main crop is cotton, which is usually marketed as soon as it is removed from the gin, there is no necessity for large or expensive buildings of this class. Cattle sometimes need shelter during January and February, but as a rule they can remain out during the entire winter. On the other hand, additional buildings for housing machinery are badly needed.

About 35 per cent of the farms in the area are operated by the owners, a large proportion of the remainder being farmed on shares. Cotton lands are always rented for a share of the crop produced. A profitable yield of this crop is so uncertain and the market price so variable that there is too much risk involved in renting these lands on a cash basis. However, a cash rental is sometimes paid for lands cultivated to grain or used for grazing purposes. When land is farmed on shares the tenant furnishes the seed, farming machinery, work animals, and labor, and receives two-thirds of all the crops produced, with the exception of cotton, of which three-fourths is usually retained. When cash is paid cultivated lands rent for about $5 an acre, but grazing lands are rented at a much lower figure.

The census of 1900 gives the average size of the farms in McLennan County as 109 acres. A few of the ranches in the northwestern part of the area cover more than 640 acres, but in the vicinity of the towns and in the timbered section east of the Brazos River many contain less than 50 acres.

The labor employed in the area consists of whites, negroes, and Mexicans. The proportion of whites and negroes is nearly equal, and there are comparatively few Mexican farm laborers. As a class, the labor employed is of a very efficient character, and is usually plentiful except during the cotton-picking season. If hired by the day, the wages paid average about $1 and board, but for cotton chopping the price is slightly higher—from $1.25 to $1.50 a day. A large proportion of the farm labor is employed by the month or for longer periods, and is usually paid from $20 to $25 a month with board. During the cotton-picking season labor is always scarce, and large numbers of laborers, both white and colored, leave the towns and city for work in the cotton fields. The price paid for this work varies from 60 to 80 cents per 100 pounds, but after a large part of the crop has been picked a higher rate is paid for gathering that remaining on the stalks.

The chief crop raised in the area surveyed, as well as in all parts of the black prairie belt, is cotton. The importance and extent of the production of cotton is emphasized by the fact that in the area under consideration there is a gin for every 20 square miles of territory or less, and that McLennan County produced 85,000 bales in 1904. The idea of diversification of crops has been gaining ground in the last few years. This tendency is of vast importance to the future of agriculture in this community.

The soils, as shown by the soil map, vary from light sandy loams to extremely heavy clays, making the area adapted to a great diversity of crops. Probably the main reason for the adherence to the one-crop idea has been that a large proportion of the farmers were dependent upon the merchant for their supplies, who always bases the amount of his loan on the acreage and probable yield of cotton. In other words, cotton is cash, and the merchant is practically safe, for every bale is marked and recorded at the gin, and can not be marketed illegally without ultimate detection. However, the financial condition of the farming class has greatly improved, until now a comparatively small proportion of the cotton crop is mortgaged.

Cotton is at present cultivated to some extent on almost every farm in the area and on many it is the only crop grown. Wheat is grown in some sections of the area, and oats and corn are cultivated to some extent on almost every type of soil, though as a rule there is not enough grain produced in the area to supply the demand on the local markets. Enough corn is produced in an average season to feed the stock, but if there is an exceptionally dry season it is often necessary to import it for that purpose. The growing of fruits (peaches, plums, and pears) is rapidly becoming an industry of considerable magnitude in the area. There are several large orchards in the vicinity of Waco, and the number of orchards is rapidly increasing in other sections of the area. The cattle industry is still of some importance, although it is now confined to the rough and more broken section of the area which is least adapted to farming. There are at present a few ranches that have from 400 to 600 head of cattle on them, but the average farmer seldom keeps more than 6 or 8 head.

The heavy limestone soil, mapped as Crawford clay, is recognized as being better adapted to the production of wheat than any of the other soils in the area, and with the exception of a small acreage of Houston black clay devoted to this crop, it produces almost all of the wheat grown in this locality. The average crop of oats on these heavier soils is also large and the results excellent. The Miller fine sandy loam is well adapted to truck, peaches, plums, pears, small fruits, and alfalfa. The truck farm located on this type a few miles southeast of Waco demonstrates that the growing of early truck on a larger scale could be made a very profitable industry. A large proportion of the alfalfa grown in the area is also found on this soil and from 3 to 5 cuttings are annually secured. The peaches, plums, pears, and small fruits are grown almost exclusively on the lighter soils and the Susquehanna fine sandy loam, Miller fine sandy loam, and Crawford loam are all well adapted to their production. A large proportion of the corn produced is grown on the Yazoo heavy clay, Miller heavy clay, and Yazoo clay. These soils produce excellent yields, and the crop is seldom damaged from either drought or overflow. The boll weevil has not damaged the cotton crop on any soil type to such an extent as to make its cultivation unprofitable. That grown on the upland prairies has never been damaged to any great extent, although a small percentage of the crop has annually been destroyed. On all of the lowland types, however, the boll weevil frequently destroys a considerable proportion of the entire crop. The condition in the low, flat valleys along stream courses seems better suited to the weevil than the rolling prairie sections, and the fact that the cotton cultivated on these bottoms is liable to serious damage by this pest has, in some localities, caused the value of the land to depreciate.

Small spots, seldom more than a fraction of an acre in extent, occur in the heavier types of soils in all sections of the area, on which cotton, potatoes, and fruit trees wilt and die. These small areas are locally known as "alkali spots," but the damage to the crops is not due to the presence of any harmful salts but to a fungous growth which affects the roots of the plants. The greatest injury to the crops affected occurs always during a wet season. The plants come up apparently in a healthy condition, but wilt, turn yellow, and die before the crop can mature. Oats, corn, and sorghum can be successfully grown on these areas.

Excellent transportation facilities are afforded by the seven railroads which traverse the area. Six of these roads, the Houston and Texas Central, International and Great Northern, Missouri, Kansas and Texas, Texas Central, St. Louis Southwestern, and San Antonio and Aransas Pass, extend into Waco, which is the most important shipping point in the area, and the western part of the county is traversed by a line of the Santa Fe system. These roads connect the area surveyed with the important markets both north and south, and every locality is within easy reach of some shipping point. The Brazos River is spanned at Waco by two large bridges, and durable iron bridges have been constructed over most of the smaller streams on all important county roads. During dry weather the county roads are excellent, but they become almost impassable after heavy rains. A few gravel roads have been constructed, which extend from Waco some distance into the black prairie sections. Where this material has been used the roads are always in excellent condition and traffic over them is never impeded even during the worst seasons. Waco is the principal market for all the products of the area. A considerable amount of fruit is now annually shipped to cities both north and south of the area, but there is usually a ready market at Waco for all the fruit and vegetables grown.

Most of the cotton produced is also sold on this market, but a part of this crop is usually sold first to merchants and cotton buyers in the smaller towns and is later bought by the cotton brokers at Waco, whence it is shipped to various parts of the United States or to foreign countries. Fort Worth is the market for most of the cattle raised in the area, but a few are also shipped to Kansas City.

The area as a whole is one of the most prosperous agricultural districts of the State of Texas. The soils are productive and well adapted to a great diversity of crops, the climate is mild and healthful, the transportation facilities are excellent, and the situation is central and in easy reach of the larger markets both in Texas and at a greater distance.

SOIL SURVEY OF LEE COUNTY, TEXAS.

By **JAMES L. BURGESS** and **W. S. LYMAN.**

LOCATION AND BOUNDARIES OF THE AREA.

Lee County is situated in the Coastal Plain region of southeastern Texas and is approximately 150 miles from the coast. Meridian 30° west longitude and parallel 29° 20′ north latitude intersect a few miles south of Lexington. The boundaries of the county are irregular, owing to its having been taken piecemeal from the counties surrounding it. On the northwest and north it is bounded by Williamson and Milam counties, on the north and east by Burleson County, on the east and south by Washington and Fayette counties, and on the west by Bastrop County.

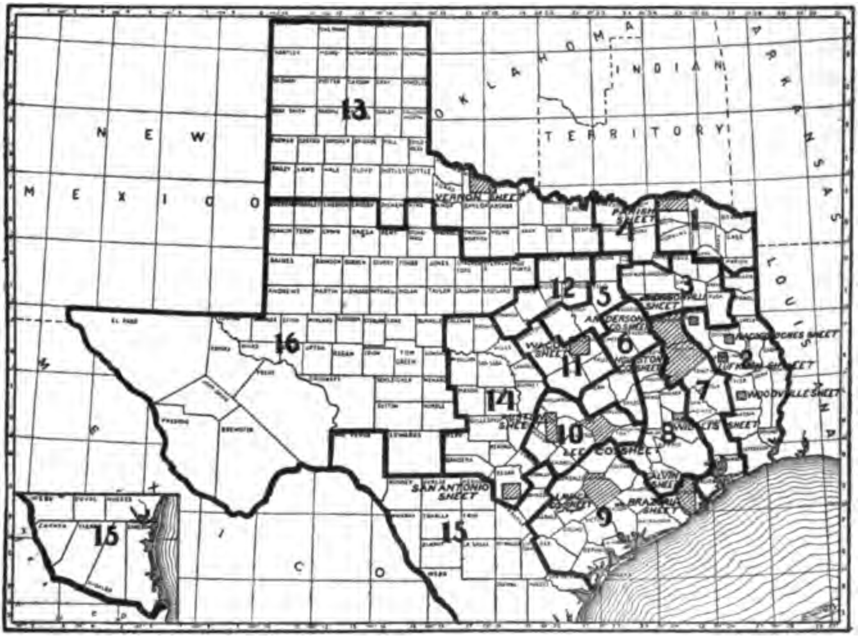

FIG. 24.—Sketch map showing location of the Lee County area, Texas.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The present county of Lee was formed in 1874 from portions of Burleson, Bastrop, Fayette, Washington, Williamson, and Milam counties. The first American settlers came to this section of Texas some thirty-five years earlier, when trading posts were established on the present sites of Lexington and Lincoln. These were followed thirteen years later by a colony of Germans, who located at Serbin. The population of the country grew slowly till after the civil war, when a number of Bohemians and Germans came in as settlers. Some located near the old German settlement at Serbin, while others selected land at various points in the southern and southeastern part of the county. In 1870 a colony of Danes attempted a settlement in the northern part of the county, but climatic conditions were unfavorable and the colony was broken up. A colony of Bohemians located at Dimebox in 1880, and is in a prosperous condition. Most of the German and Bohemian immigrants make thrifty, prosperous citizens. Practically all the American element of the population came from the Southern States.

When American settlers first came to this part of Texas most of the land was open prairie and was devoted largely to cattle raising, other forms of agricultural pursuits receiving little or no attention. Practically no cotton was produced and very little corn was grown. The prairies were covered with tall grass, on which cattle lived the year round, no other forage being necessary. The growth of chaparral was kept down by the custom of burning the dry grass in the fall and spring. In 1859 there occurred one of those abnormal changes in climate which must always be reckoned with in the Southwest. The land became so parched during this dry year that only a small amount of grass grew on the prairies, and from this time on, the older settlers say, the chaparral gained an ascendancy over the cattle ranges, and the once rich pasture lands became covered with a dense growth of post oak and black jack bushes. The number of cattle that could subsist in the open pasture lands was greatly reduced, and many of the cattlemen were compelled to leave the country in quest of new grazing lands. Those who were so situated as to be unable to move away began to grow cotton and corn. About this time the war came on and much diversification became necessary. Not only cotton and corn, but wheat, oats, and other crops were produced with remarkable success. On the heavy prairie lands it was not unusual to get a yield of 30 bushels of wheat and 80 bushels of oats to the acre, while corn always gave good yields on these soils. After the war the price of cotton rose so high that, in comparison, the production of the grain crops became unprofitable and was abandoned. Besides, the farmers were located so far from markets that the cost of hauling a product of low value scarcely justified the effort.

Prior to 1871 most of the cotton was marketed at Brenham, in Washington County, but during that year the Houston and Texas

Central Railroad was completed through this part of the State, and Giddings became the shipping point for many of the farmers. In 1889 the main line of the San Antonio and Aransas Pass Railway, connecting Waco and San Antonio, was built through this county, thus giving the farmers an outlet to the north.

The boll weevil has been the only severe pest the farmers have had in this area. The last good crop of cotton was produced in 1899. Since then the crop has been reduced from 22,804 bales in 1899 to 8,000 bales in 1904. At present the ravages of the weevil are not so severe as heretofore.

CLIMATE.

The climate of Lee County is quite mild. There is neither extreme heat nor extreme cold. During the midsummer months the thermometer sometimes registers as high as 104° F., and during the midwinter months the temperature occasionally falls below zero, but these extremes have occurred, according to local records, only once in fourteen years. The accompanying table shows the mean annual temperature to be about 68°. The extremes of heat and cold generally range from 45° in winter to 90° or 95° in summer. The annual rainfall is about 35 inches, nearly one-half of which comes during winter and spring. July and August are comparatively dry months, as are October and November.

The latitude of this area would suggest a much higher summer temperature than exists, but excessive heat is prevented by the prevailing winds from the Gulf, which are nearly always to be felt. Notwithstanding the equable climate which usually prevails, there are occasional departures that cause serious trouble in case the farmer has not guarded against them. "Hot winds" from the north—dry, hot, land breezes—sometimes parch the crops in summer, and in the winter and early spring the "Texas norther" may be expected, and with it occasionally come temperatures below zero. The warnings of the Weather Bureau should always be carefully heeded by all fruit and truck growers of this section and steps taken to offset the evil effects of these sudden changes as far as practicable.

It is said that once in about every five or six years there occurs an exceptionally dry spell that cuts short all crops, and is especially harmful to corn. These dry years can be guarded against only by proper care in the conservation in the soil of the moisture derived from winter and spring rains.

The last killing frost in spring comes about February 20, and the first in fall occurs about November 20. Thus the growing season is nearly nine months long, and of some crops two harvests may be gathered in one year.

The following table shows the normal monthly and annual temperature and rainfall at Austin and Brenham, points located approximately at equal distances west and east of this area:

Normal monthly and annual temperature and precipitation.

Month.	Austin.		Brenham.		Month.	Austin.		Brenham.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*In.*	*°F.*	*In.*		*°F.*	*In.*	*°F.*	*In.*
January	48.7	2.47	52.5	4.56	August	84.1	2.43	83.9	2.50
February	52.7	1.88	53.8	2.51	September	78.6	3.72	78.9	3.11
March	60.2	2.22	62.2	3.08	October	69.3	2.77	70.7	2.80
April	69.0	4.05	69.6	3.38	November	59.0	2.26	60.6	4.30
May	76.5	4.40	75.8	3.17	December	52.2	2.80	54.5	3.25
June	82.2	2.51	81.4	4.92	Year	68.1	33.81	69.0	40.50
July	85.1	2.30	83.9	2.92					

PHYSIOGRAPHY AND GEOLOGY.

Lee County lies wholly within the Gulf Coastal Plain. It is inclined to the southeast and south and has a general slope of about 4 feet to the mile. The divide between the Colorado and Brazos rivers crosses the southern part of the county, which is wholly drained by tributaries of these streams. The county has a mean elevation of about 400 feet above tide water and is thought to be outside of the artesian water and oil belt of the State. There is, however, a weak flow of artesian water in the county.

The main divide mentioned above is represented between Giddings and Ledbetter by a broad, flat, mesalike area from 1 to 3 miles wide. This belt becomes narrowed west of Giddings, where it takes a northwesterly direction, and culminates in what is known as the "knobs," a range of low hills composed of ferruginous sandstone.

South of this divide the surface is more rolling and is drained by Robbs, Knobs, and Pin Oak creeks, all of which flow into the Colorado River. The bottom lands along these creeks are narrow, and the bluff lines, while precipitous in some places, usually have very gentle slopes, and the bottom lands are rarely more than 50 feet below the surrounding uplands.

North of this divide is the drainage basin of West, Middle, and East Yegua creeks, which find their way to the Brazos River. Middle Yegua Creek flows across the county a little south of east and drains the larger part of the area. The bottom lands along these streams range from one-fourth to more than 1 mile in width. At some points along the lower courses of the Yegua creeks the bluff lines are quite precipitous on the south side, the bluffs rising sometimes as much as 100 feet above the stream bed.

The surface of the county as a whole may be described as gently rolling. The streams have carved out broad, shallow valleys, however, in which are many ravines and channels of small streams that cut the surface of the land near the line of drainage into many inequalities. Some of these are so pronounced that small areas skirting the streams and lying around the heads of draws are rendered uncultivable. The greatest inequalities of surface are found in the western part of the county in the vicinity of the "knobs" and in the eastern part where Nails and Cedar creeks join the Yegua. Other minor inequalities occur near the county line west and northwest of Serbin, along the lower course of Robbs Creek and on each side of the divide west of Giddings. Generally the surface is somewhat rough and broken at the junction of the uplands proper with the different major and minor drainage basins. Few of these dissected strips are too rough for cultivation and usually the farmer drives his horses directly from the uplands onto the bottom lands in cultivating his crops.

In the southern part of the county are broad ridges of gravel and stone, while in the northern part are broad ridges and large areas of deep, white sand. Scattered areas of clayey soils known as "mesquite prairies," because of the predominance of mesquite bushes in the native vegetation, are scattered here and there over the county. A chain of these prairies extending from Dimebox to Paige, in Bastrop County, is known as San Antonio Prairie. Another, called String Prairie, extends from Lexington to East Yegua Creek.

The soils of Lee County are influenced by two distinct geological formations. In the southern part of the county are found large areas of gravel, much petrified wood, fine sands, some soft fine sandstones, and gray to dark-gray mottled clays. According to Adams[a] this formation belongs to the Jackson stage of the Eocene Tertiary.

North of a line running across the area approximately parallel with West Yegua Creek occur soils of a very different nature from those found south of this line. Both the soils and the topographic features of the country indicate an older formation than that lying in the southern part of the county. The fossil remains found in the marly clays are similar to those of the Eocene age found in other parts of the State, and according to the authority cited above this formation belongs to the Lower Claiborne stage of the Eocene Tertiary.

SOILS.

The soils of Lee County vary a great deal in respect to mechanical composition and agricultural value. These differences are at once recognized by the farmer when he comes to grow crops on them. Inequalities of depth, irregularities of composition of subsoil, varied drainage features, and different drought-resisting capacities all present a complicated soil problem which it is difficult for the average farmer to solve.

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[a] Bul. 184, U. S. Geol. Survey.

The different types found in the area are frequently badly mixed, and it has been necessary in the mapping to ignore small tracts of a few acres, but these will at once be recognized by the farmer from the descriptions of the various types. Ten different types of soil were recognized and mapped in Lee County. The following table shows these in the order of their extent:

Areas of different soils.

Soil.	Acres.	Per cent.
Lufkin fine sandy loam	113,152	26.6
Orangeburg fine sand	69,696	16.4
Orangburg fine sandy loam	57,920	13.6
Lufkin gravelly loam	47,360	11.1
Norfolk fine sand	41,856	9.8
Houston black clay	38,208	8.9
Sharkey clay	28,096	6.6
Meadow	13,760	3.2
Orangeburg clay	10,688	2.5
Lufkin loam	5,376	1.3
Total	426,112	

LUFKIN FINE SANDY LOAM.

The Lufkin fine sandy loam is a fine sandy loam, sometimes heavy, but generally very light in texture. It frequently contains a small percentage of gravel, the amount of which increases where it comes in contact with the Lufkin gravelly loam. The color varies from a gray to dark gray, depending on the amount of organic matter, which in turn depends largely on topographic position. Some small areas are found that are of a reddish hue, and again certain local conditions may cause the soil to become much darker. The gray color everywhere predominates, however, and changes to a reddish or darker color only where local conditions of drainage and aeration have influenced oxidation.

This type varies greatly in depth. On some of the hillsides and around the heads of draws where erosion has been quite active the soil is frequently not more than 3 inches deep, and in many places the heavy clay subsoil comes to the surface. Along the divides and in the more level areas the soil is much deeper, averaging about 15 inches. On examining road cuts and making borings in the field the depth of this soil was found to be very irregular, even on the broader divides, the clay subsoil coming within 3 or 4 inches of the surface, then dropping almost abruptly as much as 18 or 20 inches, and coming nearly or quite to the surface again only a few feet away.

The subsoil of this type is a stiff sandy clay. The texture is not everywhere the same, but the variations are not wide. In depth it varies from 3 to 36 inches, and usually becomes lighter in texture as the depth increases. At 36 inches there is an increase in the proportion of sand, thus affording better drainage conditions than would otherwise exist. There is usually a perceptible amount of lime and gypsum in the subsoil. In color it is gray to dark gray, with occasional red and yellow spots scattered through it. As a rule the red and yellow subsoils underlie areas of thin soil where the surface is more rolling. The stratum of red or yellow is rarely more than a few inches thick and grades quickly into the gray clayey material beneath. The line of contact between the soil and subsoil is quite well marked, there being practically no gradation from the one to the other. During dry seasons the subsoil, unless covered by a good depth of soil, cracks deeply and opens large crevices into which subsequent rains descend, thus increasing the amount of water stored for the crop.

Although this soil has great water-holding capacity, the fine sand of which the soil is largely composed allows capillarity to work very rapidly, and unless due care is exercised in the preservation of moisture, crops will quickly suffer. Crops are frequently lost on this soil when an unusual dry spell occurs, while they are uninjured on other soils in the area in which capillarity acts more slowly.

The Lufkin fine sandy loam is found almost wholly south and east of an irregular line formed by Elm, West Yegua, and Middle Yegua creeks. There are a few small areas north of Middle Yegua Creek, but practically all of this soil lies in the southeastern part of the county, where it is the predominant type.

The greater proportion of this type is level to gently rolling, with here and there a moderately deep ravine that fingers out from some drainage channel. In the immediate vicinity of streams and around the heads of draws the surface is rougher, and in some cases small areas are found so dissected by ravines and gulches as to be of little agricultural value. The most level areas of this type lie east and northeast of Giddings.

The drainage features of the Lufkin fine sandy loam are generally good except along the main divide marking the rise of several small streams flowing either to the north or south. Along this divide there is some land that must be drained in order to insure good crops. During wet seasons the water stands on the surface and the heavy subsoil prevents it from percolating downward rapidly enough to keep the crops from suffering. Open ditches would probably be the cheapest method of reclaiming these low, flat areas. The water would be carried away rapidly, but there would be little erosive action accompanying this method of drainage.

This soil is derived from the weathering of sands, sandy clay, and arenaceous shaly beds of the Jackson stage of the Tertiary. During the process of weathering, the fine sands, of which there is a considerable amount in these clays, have been separated from the clayey matrix in which they were held and allowed to remain in place while the rain waters removed the finer earth from the surface. This type is, therefore, of sedimentary origin and represents the weathered product of a comparatively recent coastal deposit.

Large tracts of the Lufkin fine sandy loam are yet in the virgin state and only a small percentage of it has been cleared and placed under cultivation. The only crops so far grown are corn and cotton, and after the first two or three years of cultivation the yields are moderate. From 15 to 20 bushels of corn and one-fourth to one-half bale of cotton to the acre are the average yields. It is probable that certain fruits and vegetables would do well. It is on a soil similar to this that Cuban filler tobacco is grown in Lavaca County. Where the soil is thoroughly drained and from 10 to 15 inches deep it is quite probable that peaches would prove profitable, and there is little doubt that tomatoes, beans, and other vegetables which thrive in a light soil would prove remunerative to the grower.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lufkin fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13746, 13748	Soil	0.3	0.7	2.5	35.5	29.1	26.1	5.3
13747, 13749	Subsoil	.1	.5	1.6	23.6	25.6	24.1	24.0

LUFKIN GRAVELLY LOAM.

The Lufkin gravelly loam is characterized by the large amount of gravel in or immediately under the surface soil. The native vegetation is a mixture of black-jack and post oaks. The depth of the soil varies from 0 to 15 inches, and the fine earth mingled with the stones and gravel is generally a gray fine sand, though heavy areas are found that approach a clay loam in texture.

The subsoil is always a heavy sandy clay, ranging in color from red to yellow and gray, with the red color predominating. It has a depth of from 2 to 3 feet and grades into arenaceous shale.

The most of this type is found in the southern and eastern part of the county and in general is associated with the Lufkin fine sandy loam. It is found upon the divides between the larger streams and sometimes extends down to the bottom lands along them.

The surface of this type is generally rough and hilly and the most of it is used for pasture. Steep-sided ravines and gulches cut through large areas of this type and render it useless for cultivation.

There are small areas of this gravelly soil that are level enough for the plow, and when carefully handled produce fair crops.

The drainage of this soil is perfect. Like the Lufkin fine sandy loam, this type is derived from the weathering of the underlying sandy clay and shale beds. The stones and pebbles are invariably siliceous and are generally composed of chert, showing their origin to have been from the breaking down of limestone strata which belonged, in all probability, to the Cretaceous age. The stones and pebbles are all well rounded and doubtless represent the shingle of some old shore line. This is, therefore, a sedimentary soil derived from the weathering in place of Tertiary deposits.

Only a small proportion of this type is under cultivation. Corn and cotton are the crops grown, with yields of about one-third bale of cotton and 15 bushels of corn to the acre. Where the surface is not too rolling and the amount of gravel not too great, good crops could be produced. It is naturally a fairly strong soil. It contains much lime and gypsum and should produce good crops once it is put in good mechanical condition. It is on this type of soil, where the clay is from 6 to 10 inches below the surface, that a good quality of dill, caraway, and coriander are grown in some parts of the State.

The following table gives the results of mechanical analyses of the fine earth of soil and subsoil of this type:

Mechanical analyses of Lufkin gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13763	Soil	0.4	0.8	1.1	36.5	41.2	11.9	8.9
13764	Subsoil	.7	.5	1.7	16.9	15.9	20.5	43.8

HOUSTON BLACK CLAY.

The soil of the Houston black clay varies from a heavy loam to a clay loam or clay, though small areas of a few acres are frequently found where the soil is light enough to be classed as a sandy loam. This is the heaviest upland soil in the county, and is called "waxy clay land" by the farmers. Gravelly areas and areas with an abundance of iron concretions may be found. Near Lincoln there are several hundred acres of this type with sufficient gravel to be mapped as the Lufkin gravelly loam.

The soil is from 3 to 12 inches deep, the depth depending on the amount of surface erosion. The physical properties of this soil give it great water-holding capacity. During dry periods it cracks badly, many of the crevices being 3 or 4 inches wide and more than 2 feet deep. When heavy rains fall these cracks catch large quantities of water, which are stored deep in the subsoil and comparatively little of the summer rainfall escapes into the surface drains. The color of the soil is dark to dark-brown. Occasional spots of red and yellow are found where conditions of texture and drainage have augmented oxidation.

The subsoil of this type is always a heavy clay, varying in depth from 10 inches to 3 or 4 feet, where it grades into stratified clays. The subsoil carries large amounts of lime and gypsum. In color it is prevailingly dark, with here and there a thin stratum of red or yellow.

The location of this soil follows a line running in a general northeast and southwest direction across the center of the county. Small areas are found north and south of this line and are locally called "mesquite prairies." This belt of soil is not continuous across the county, but is intersected here and there by the bottom lands of the streams and by areas of other soil types. The greater proportion of this soil has always been free from forests, and since it was early traversed by the main line of overland travel from Caldwell to San Antonio it is popularly known as the San Antonio Prairie.

The surface of the Houston black clay is gently rolling, and it is nowhere too rough for cultivation. There are some fields with small ravines that might prevent the use of modern machinery, but these heavily rolling areas are not large and usually occur near streams. The surface drainage of the type is good, as a rule, only a few local areas needing artificial drainage. Water moves slowly through the subsoil, but the rolling surface prevents water-logging.

The Houston black clay has been under cultivation for several years, but thus far cotton, corn, and oats have been the only crops grown. It is the strongest upland soil in the area, and is well suited to the staple crops. Owing to the large quantity of water stored in the subsoil, crops of corn and cotton remain unharmed through long dry periods on this soil, while the vegetation on some of the other types dies for lack of moisture. Under favorable conditions corn will produce 50 bushels, and cotton from one-half to 1 bale to the acre. It is quite probable that alfalfa, if properly seeded, would do well on this soil. Much of it is now used for pasture and meadow. It is on this type that the root rot of cotton is most serious. Deep plowing and frequent cultivation are recommended for cotton grown on this soil. The cultivation should be continued until August 15, and the cotton should be topped rather low, so that the plant may branch out and shade the land early in the season.

The following table gives the average results of mechanical analyses of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Houston black clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13740, 13744	Soil	1.1	1.8	1.1	11.2	18.6	38.4	27.8
13741, 13745	Subsoil	.7	.9	1.4	12.9	10.1	34.5	38.6

ORANGEBURG FINE SANDY LOAM.

The Orangeburg fine sandy loam is characterized by a uniform color of soil and subsoil, a large amount of iron concretions, fragments of ferruginous sandstones, and a forest growth of post and black-jack oak. The soil varies in depth from 6 to 15 inches over most of the type. There are, however, small spots and strips of the Orangeburg fine sand scattered through it. The soil is a medium to fine sand, reddish-brown to gray in color, and is slightly loamy where the subsoil comes close to the surface. It does not contain much organic matter.

Much of this soil is yet in its virgin state, being covered with oak forests and used for pasture. It is not naturally a retentive soil, but its capacity for holding moisture can be greatly increased by the plowing under of green crops or the use of stable manure, straw, leaves, or other organic matter. Its light texture makes it an early soil and in its virgin state it is quite productive.

The subsoil nearly always consists of a red sandy clay, usually more than 3 feet deep. The clay content is rather high and the capacity for holding moisture relatively great. Small iron concretions are abundant throughout both soil and subsoil and aid materially in the drainage of the type. The subsoil is underlain by stratified clays that everywhere lie horizontal.

With the exception of a good-sized area of this soil north and south of Old Serbin, the most of it is found north of Middle Yegua Creek in the northern part of the county, and around the headwaters of that creek in the extreme western part of the county. The surface is rolling but not too rough for cultivation, except over a small area in the western part of the county, in the range of low hills known as the "knobs." The drainage of the soil is everywhere very good.

This soil is derived from the weathering and disintegration of the sandy clay beds of Eocene Tertiary age. During the process of weathering the fine earth has been carried away in the drainage waters. The sand is largely siliceous, only a small amount of feldspathic fragments being present.

Cotton and corn are the only crops thus far grown to any extent. On new land corn yields from 30 to 40 bushels and cotton from one-half to three-fourths of a bale to the acre. The virgin fertility is soon lost under continuous cropping and it is important that some system of crop rotation be practiced by which large amounts of organic matter may be retained in the soil. It is recommended that a three-year rotation of cotton, corn, and cowpeas be practiced on this soil. The pea vines should always be left on the ground and turned under as soon as the hogs have harvested the peas.

The Orangeburg fine sandy loam is an excellent truck and peach soil and would, in all probability, produce an excellent quality of cigar tobacco. There is little doubt that the truck and fruit industries will be largely developed on this type of soil in this county. Already the attention of fruit growers and truckers is being called to the feasibility of locating commercial peach orchards and truck farms around Lexington, where large areas of this soil are found. On this and other light soils in the county there would be little risk in attempting to grow melons, cucumbers, white and sweet potatoes, egg plants, beans, and peas; but cabbage, cauliflower, and bulb crops are not recommended for this soil.

The following table gives the average results of mechanical analyses of the fine earth of the soil and subsoil of this type.

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13759, 13761	Soil	0.8	1.7	3.4	43.1	31.9	13.7	5.4
13760, 13762	Subsoil	.3	.6	.8	9.5	15.9	19.2	53.9

LUFKIN LOAM.

The Lufkin loam is characterized in this area by its generally flat surface and a native growth of live oak trees. The soil is from 3 to 10 inches deep, grading from a heavy loam to a fine sandy loam, and contains a fair amount of organic matter. It is dark gray in color and usually compact in structure. This soil puddles easily and must be handled carefully to prevent it from "running together." The subsoil is a stiff, compact, dark-colored clay, inclined to be sandy.

The most important body of the Lufkin loam lies 3 miles east of Giddings, on both sides of the Houston and Texas Central Railroad. It marks the apex of the divide between the Colorado and the Brazos rivers. The surface of this type is only gently rolling and for the most part is nearly flat. It is poorly drained, the rain waters moving but slowly toward the drainage channels. The subsoil being of a heavy, compact nature, the subdrainage is also poor. During wet springs crops suffer from standing water. Open ditches would be efficient in correcting this condition. As the surface is so nearly level there would be little damage from erosion.

The Lufkin loam is derived from the weathering of the sandy clay beds of Tertiary age. The soil differs from the Lufkin fine sandy loam, which has a similar origin, only in the fact that clays and silts from the surrounding uplands have accumulated on the nearly flat surface of this soil and have been gradually incorporated with the fine sand, making a heavy loam. The subsoils of the two types are, in many respects, much the same.

Corn and cotton are the crops generally grown on the Lufkin loam. It is a strong soil and crops give good yields when the season is not too wet. Corn produces from 25 to 35 bushels and cotton from one-fourth to three-fourths of a bale to the acre. It is quite probable that certain varieties of truck would yield profitable returns on this type. In some parts strawberries are successfully grown, and no doubt cabbage, cauliflower, and similar crops would do well.

As this soil puddles easily, care must always be taken to keep it well mulched with a layer of fine, dry soil by frequent cultivations during the growing season. Capillarity works very rapidly in this soil, and only a few days neglect might allow large stores of moisture to escape by evaporation during hot, windy weather.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lufkin loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13765	Soil	0.2	0.9	3.0	34.1	26.1	21.6	13.6
13766	Subsoil	.0	.4	1.8	26.1	15.7	17.0	38.3

NORFOLK FINE SAND.

The Norfolk fine sand, a fine, loose, gray sand, is uniform in both color and texture. The material is always over 3 feet deep, and there is generally little or no difference between the soil and subsoil. The soil has a little more organic matter than is found in the subsoil, but otherwise the two are nearly identical. Only a small percentage has yet been reclaimed from forest conditions.

This soil is located north and west of a line running through the center of the county in a northeastern and southwestern direction, passing through the towns of Manheim, Lincoln, and Dimebox. The largest continuous areas are found in the extreme northern part of the county, in the vicinity of Tanglewood. The surface is everywhere rolling, and the sand is deep enough to insure perfect drainage.

Some small areas occur near the "knobs" that are too rough for cultivation.

In this area the Norfolk fine sand, in all probability, represents the sandy beaches of ancient shore lines that existed in early Tertiary time. Its relationship to the Orangeburg clay and the Houston black clay, both of which are undoubtedly of marine origin, tends to strengthen this view. These sands have undergone considerable weathering, but it is hardly probable that they have, as a whole, ever been more consolidated than they are to-day. An exception to this is found in the case of that portion of the type found around the "knobs," which is doubtless derived from the disintegration of the ferruginous sandstones of which these hills are composed.

This soil is so light that it is generally considered of little agricultural value, and only a small area is planted to crops. When first cleared it yields fair crops of cotton, but corn makes only an indifferent growth. It is not so droughty a soil as might be supposed, since the fine, incoherent sand tends to keep the surface mulched and the soil water escapes only by percolation. Green manuring would greatly improve the water-holding capacity of this soil.

The Norfolk fine sand is well adapted to the production of watermelons, which are grown and shipped to northern markets. Peaches will do well on this soil if properly managed, and there is little doubt that the growing of grapes could be made profitable. Tomatoes would do well, and would prove profitable if planted so as to mature for early market.

The following table gives the results of a mechanical analysis of a sample of this type:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18752	Soil	0.1	0.2	1.2	57.8	27.1	10.8	2.7

ORANGEBURG FINE SAND.

The Orangeburg fine sand is composed of medium to fine sand, loose and incoherent for the most part, though occasional spots are found that approach a sandy loam texture. The depth of the soil varies from 18 to 36 inches. In color it is a gray to yellowish-gray. The subsoil is nearly always a red sandy clay, changing sometimes to a clayey sand. It usually gets more sandy with depth and at 30 to 36 inches frequently changes to a gray sandy clay grading into the stratified sandy clays below.

This type is located mostly in the northern and western part of the county. Some long, narrow strips are found in the south, along

Nails and Middle Yegua creeks. It is most typically developed around Lexington and northwest of Lincoln. Large areas are also found east and north of Lexington in the vicinity of Middle Yegua and Brushy creeks. The surface of this soil is always rolling and the undulations sometimes culminate in low hills, but nowhere is the surface too rough for cultivation. The drainage is almost perfect. There are, however, a few low, flat areas near stream channels which are liable to become water-logged during long wet spells. All these low places, and all depressions into which cold air is likely to drain, should be carefully avoided by peach growers and market gardeners.

The origin of this soil is the same as that of the Norfolk fine sand, the only distinctions between the two being a slight difference in mechanical composition, the former having more heavy material than the latter, and a difference in depth, the Norfolk type always being over 3 feet deep.

The crops at present grown on the Orangeburg fine sand are cotton and corn. In its virgin state the yields are good—25 to 30 bushels of corn and from one-third to one-half bale of cotton to the acre. The humus is soon exhausted from this soil and systematic green manuring is recommended to maintain its productiveness. This is a good truck and peach soil and commercial orchards and gardens would doubtless prove remunerative if located sufficiently near a shipping point. The crops suggested in the discussion of the Orangeburg fine sandy loam would be suitable for this type.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13757	Soil	0.2	0.4	1.1	68.5	15.6	8.6	5.6
13758	Subsoil	.5	.5	.6	38.3	12.5	9.1	38.5

ORANGEBURG CLAY.

The soil of the Orangeburg clay varies in depth from 3 to 10 inches and is characterized by a prevailingly red color. In texture it grades from a heavy sandy loam to a loam. The soil contains many iron concretions and occasional fragments of marly rock are found. It usually contains much organic matter, giving it the dark-red hue. The subsoil usually extends to a depth of more than 36 inches, but sometimes grades into consolidated marly clays at 30 inches below the surface. Fragments of marly rock of a yellowish-brown color are also found scattered through the subsoil. These rock fragments contain shells and casts of shells, showing the origin of the soil.

With the exception of two small areas west of Fedor and a few spots in the extreme western part of the county, the whole of this type is located north of Middle Yegua Creek, in the northern part of the county. The largest area is String Prairie, extending from Lexington east to East Yegua Creek. Other smaller areas occur north of Lexington along Brushy Creek, and in the extreme northeastern part of the county. The surface of this type is everywhere rolling, but nowhere is it too rough for the plow. String Prairie contains some areas of this soil that are only gently rolling. Along the line of contact with the sandy areas to the north and south there is a narrow, though not continuous, strip of land, that is too much dissected for cultivation. The surface drainage of this type is good, except on a few small flat areas in String Prairie which would be benefited by tiling.

This soil, like the Houston black clay, is of marine origin and belongs, in all probability, to the Eocene Tertiary. From the included fossil remains it is evidently a salt-water deposit, and the present outlines of the larger areas show the deposition to have been made in a narrow sound. Since the surface of the soil areas has been elevated the elements have caused a general disintegration of the beds in the upper 6 to 10 feet and the material has been oxidized and changed from a dark-green to a red or yellow color. There exist to-day, at only a short distance from the surface, well-preserved beds of greensand marl. Surface erosion, acting in conjunction with cultivation, has removed from the surface large amounts of fine earth and changed the soil from a clay loam to a loam or sandy loam.

This soil type contains much lime in the subsoil and is recognized as one of the best cotton and corn soils in the county. Corn yields from 30 to 40 bushels and cotton from one-half to three-fourths of a bale to the acre under favorable conditions of climate and cultivation. Most of this soil is now under cultivation, it being the soil on which settlers in this part of the State first located. Some of it is in meadow and good crops of Johnson grass hay are secured. It is probable that alfalfa would do well on this soil. There is an impression among the farmers that commercial peach orchards can be located on this type of soil. This impression seems to have originated from the fact that the soil is uniformly red, the idea being that red soils make highly colored fruit. While the red color is not objectionable, this soil is much too heavy, rich, and generally too poorly drained, even on the hillsides, for growing commercial peach orchards. It would doubtless be well to try small orchards to supply the family, but the planting of peach orchards on this type of soil for commercial purposes would not be advisable. It is thought that the type may produce a good grade of Cuban filler tobacco.

The following table gives the average results of mechanical analyses of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Orangeburg clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13753, 13755	Soil	1.4	1.9	1.9	21.5	21.0	26.7	25.6
13754, 13756	Subsoil	1.5	1.7	1.4	7.3	7.8	28.7	51.7

SHARKEY CLAY.

The soil of the Sharkey clay, from 10 to 20 inches deep, is usually a heavy clay, containing enough organic matter to give it a yellowish-gray to dark-gray color. Occasional spots and strips of sand occur over the surface, deposited by shifting currents during flood time. It is an alluvial soil, and on account of the irregularity of its deposition both the texture and depth of soil vary considerably. The subsoil grades from a stiff heavy clay of a dark color to a fine yellow sand. The sand is found at from 12 to 36 inches below the surface, but frequently the clay is over 3 feet deep.

This type occurs along the lower courses of the larger streams north of Giddings, but little or none is found near the sources or along the tributaries of these streams. The surface of the Sharkey clay is generally level and is subject to annual overflow, and great care must be exercised in growing crops on it. A large proportion of it should be drained both with tiles and open ditches. The open ditches would carry away the surface water, and the tile, if placed at the proper depth, would lower the water table to at least 3 feet from the surface. The drainage of most of this bottom land is quite feasible because the stream beds lie several feet below its surface.

The Sharkey clay is alluvial in origin, being composed of the finer particles carried in suspension by the streams of the area. The soil is found along the lower parts of the streams, where the overflow waters have little movement or remain impounded after the floods have subsided.

In general, only the lighter phases of this type are under cultivation. Cotton and corn are the crops grown, and fine yields are uniformly secured in good seasons. Fifty bushels of corn and a bale of cotton to the acre are not unusual yields on these bottom lands. Floods are yearly expected and the crops are frequently lost by inundation. In order more nearly to insure crops on this fertile soil it is recommended that the land be thoroughly prepared in the spring and fallowed to keep down weeds until, in the judgment of the farmer, the liability to overflow has passed, when the crop may be planted with little risk of failure.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Sharkey clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13769	Soil	Tr.	0.1	0.2	1.6	2.9	41.1	54.5
13770	Subsoil	0.0	.1	.1	.5	1.3	52.6	46.2

MEADOW.

The Meadow is quite variable, both in depth and texture of soil and subsoil. Sometimes it consists of a fine loamy sand over 3 feet deep and in other of more clayey material. As a whole, however, the soil is light in texture. It is usually from 10 to 24 inches deep and consists of a fine loamy sand containing a fair amount of organic matter. The color is gray to dark gray. The subsoil is a dark gray, fine loamy sand, usually containing more clay than the soil. The amount of heavy material in the subsoil varies considerably, and at 30 to 40 inches it sometimes changes to a sandy clay.

The Meadow is most typically developed along Robbs Creek south of Giddings, but is found along almost all the smaller streams in the county. Its surface is generally level, except where it has been cut by the swift overflow currents. It is nearly all level enough for the plow. It is subject to annual overflow, but both the surface and subsoil drainage are good and crops do not suffer from an excess of moisture.

The Meadow is an alluvial soil derived from the wash of the surrounding uplands, where the soils are generally fine sands and fine sandy loams. It is easily tilled, and most of it is under cultivation. Corn and cotton are the crops grown. The yields are low, except in the northern part of the area, where the soil is stronger than it is in the southern part. Twenty bushels of corn and one-third bale of cotton are the average yields. It is a good soil for such crops as cucumbers and watermelons, and certain varieties of pears would do well on it. Cotton would make a better yield if grown after a leguminous crop.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Meadow.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13738	Soil	Tr.	0.1	0.7	43.2	37.1	8.3	10.6
13739	Subsoil	Tr.	.1	.5	41.2	39.2	6.8	12.1

AGRICULTURAL METHODS.

In the majority of cases the practice of more modern methods of agriculture would result in increased profits to the farmers of Lee County. In planting cotton many simply throw two furrows together on unbroken land in the spring, thus forming a ridge under which lies a strip of hard, unbroken soil, and on this ridge and over this strip of hard land the cotton is planted. Some of the farmers plow the land in the spring just before or at the time of planting the crop. The plowing is always shallow, regardless of the texture of the soil. Subsequent cultivation is usually from 3 to 5 inches deep, and the ridge method is universally practiced. This ridge method should not be practiced on the upland soils, except where level cultivation would not secure proper drainage. It is recommended that shallow plowing be practiced on all the sandy soils where the clay subsoil is more than 10 inches below the surface, to be followed by cultivation not less than 3 inches deep. All clay lands should be broken deeply and followed by 3 or 4 inch cultivation. The object in both cases is to conserve moisture for use of the crop.

There are a number of farmers in the county who are following more modern methods. Some of them are practicing a mixed husbandry—growing various forage crops and marketing hogs and cattle as well as cotton. Cowpeas are grown between the rows of corn, and large areas are planted to peanuts. Both are excellent feed for hogs, and by their use good pork can be produced cheaply.

No system of rotation is practiced that has as its prime object the maintenance of humus in the soils. The sandy soils are usually in need of large quantities of organic matter for the best crop yields, and it is recommended that a four-year rotation of corn, cotton, peanuts, and cowpeas be followed on all sandy soils where staple crops are grown.

The planters of this area allow cotton to go unpruned in order to get a "top" crop. This practice is rarely ever advisable, since the early crop is of better quality than the later one, and in the experience of the best farmers the early topping of cotton adds from 25 to 40 per cent to the yield. Cotton should be topped soon after the first bolls are formed, that the vitality of the plant may be concentrated in the fruit and not distributed throughout a surplus growth of stalk.

Some of the farmers have found that a five-year rotation—corn two years, sorghum one year, and cotton one year—is effective in controlling the root rot of cotton.

AGRICULTURAL CONDITIONS.

Of the 424,000 acres of land in Lee County, about 400,000 were in farms in 1900, 32 per cent of this area being improved. There has been no great change in conditions since then, but the size of the farms is gradually decreasing and the character of the crops is slowly changing. While a majority of the farmers own their farms, the farming class as a whole can not be called prosperous, and many of the farms are mortgaged. This condition is due mainly to decreased profits in cotton growing since the advent of the boll weevil.

The farms of Lee County range from 40 acres or less to estates of thousands of acres. According to the Twelfth Census, the average size of the farms is about 133 acres. In this average, however, each tenancy is considered as a separate farm, and the individual farms contain a much larger mean acreage than the census figures indicate.

Colored labor is about the only kind available. The foreign element does not use much hired help. Men, women, and children all work in the field in the German settlements. During cotton-picking time the floating population moves here and there wherever wages invite.

The principal products in this area are cotton and corn, but only cotton is put on the market. Of less importance is the production of potatoes, oats, and peanuts. Some of the farmers are beginning to make peanuts an important product on the farm. These are fed to hogs, for which there is a ready market at Fort Worth. The cattle industry is receiving more and more attention each year, and good breeds of stock, such as Hereford and Shorthorn, are being introduced.

The business of fruit and truck growing is beginning to engage the attention of some of the farmers and business men. There is an excellent opportunity for the development of this industry in Lee County. It is quite probable that the greatest returns will come from the production of peaches and truck. There are also good tobacco soils in the county, and the production of a good grade of Cuban tobacco is quite feasible.

The adaptation of the Orangeburg clay, Houston black clay, and Sharkey clay to the production of corn has long been recognized by the farmers, although the crops gathered are not always a true measure of the fertility of these soils. Cotton also does well on these heavy soils, but the yield would be increased, it is believed, if the plants were topped earlier. The sandy soils are nearly all well suited to the growing of cotton, cowpeas, peanuts, certain varieties of truck, peaches, and Kieffer pears, provided the pear trees are located where ample moisture can be had at all times.

The farmers of Lee County have access to markets over the Houston and Texas Central and the San Antonio and Aransas Pass railroads, and most of the county is conveniently situated with reference to shipping points. The San Antonio and Aransas Pass Railway runs through the area from north to south, and the Houston and Texas Central Railroad traverses the southern part from east to west. The location of the county is such that nearly all the principal markets of the Mississippi Valley may be reached in from one to three days. The San Antonio and Aransas Pass Railway connects the area with Waco and Fort Worth, and from here Denver may be reached in about forty-eight, Kansas City in twenty, and St. Louis in thirty hours. Over the Houston and Texas Central Railroad, Austin, Houston, Galveston, and New Orleans may be reached in less than twenty-four hours.

SOIL SURVEY OF LAVACA COUNTY, TEXAS.

By **CHARLES N. MOONEY, FRANK BENNETT, A. T. STRAHORN, and H. L. BELDEN.**

LOCATION AND BOUNDARIES OF THE AREA.

Lavaca County is situated in the southern part of east Texas, in the third tier of counties from the Gulf of Mexico, its southern boundary being about 60 miles distant from the coast. The county is intersected by the ninety-seventh meridian west from Greenwich, while it is situated between the parallels of 29° and 30° north, the extreme southern portion extending nearly to the twenty-ninth parallel.

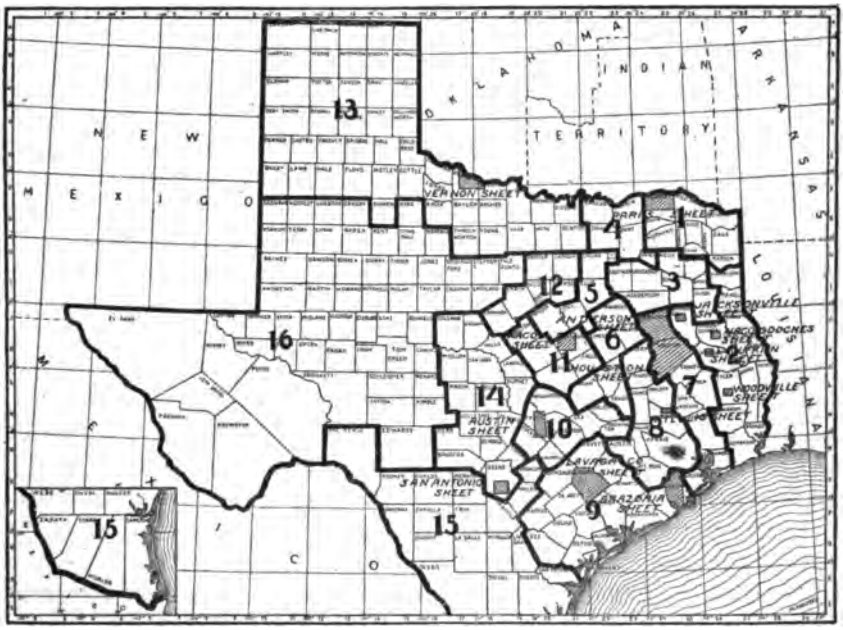

FIG. 25.—Sketch map showing location of the Lavaca County area, Texas.

Seven counties border on Lavaca County, beginning with Fayette, which touches it on the north, and then, passing to the east, south, and west, they are Colorado, Wharton, Jackson, Victoria, De Witt, and Gonzales, respectively.

The area of Lavaca County is 636,800 acres, or approximately 995 square miles. Hallettsville, with a population of nearly 2,000, centrally located in the county, is the county seat and a thriving business place. It is practically in the same latitude with Houston and San Antonio, and in an air line is about equidistant from the two places. Other towns in the county and on the railroad are Shiner, Moulton, Sweet Home, and Sublime. Yoakum, with 3,500 inhabitants, situated on the county line, but principally in De Witt County, is the largest near-by town, being a railroad junction point and shipping center.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

In 1832 a few families from Missouri settled in what is now Lavaca County. They were soon followed by more families from the same State, also from other parts of Texas, and later from the older Gulf States. Settlement was encouraged in this section at that time by the Mexican Government, inducements being offered by giving large grants of land to settlers, which was continued until Texas gained her independence, in 1836.

These early settlers located along the streams and on the border of the treeless prairie and timber belt. The former afforded them cleared land for cultivation and pasturage for stock, while from the latter lumber was obtained for building purposes, fuel, and fencing. Pasturage was also afforded in the thinly timbered regions.

The settlers brought with them live stock, which, on account of the mild climate and abundance of pasturage throughout the year, greatly increased in numbers, so that in a few years cattle grazing became an important industry.

In 1846 territory was cut off from Gonzales County and Lavaca County was organized. During the following decade German and Bohemian settlers, some from Fayette County, to the north of Lavaca, and others direct from Europe, began to locate in the county. Later this class of immigration greatly increased, and two-thirds of the county's present population has its origin in these nationalities. These people located upon the prairie and gave their attention to cultivating crops instead of stock raising.

The open range and the low-priced lands at an early day attracted the attention of cattlemen, who were being crowded out in the more thickly settled sections of the State, and this region, therefore, became prominent as a grazing section. Attention was given entirely to the native cattle, but it is said that by 1850 the more enterprising ranchmen began improving the grade of their herds with Shorthorn and Hereford blood. The cattle were at first marketed by driving them to Galveston, New Orleans, or some smaller local market. Some time after the civil war the cattle were for a few years driven to Abilene, Kans., a point on the Union Pacific Railroad, and also to St. Louis, but after the building of railroads the larger stock markets were reached through shipment at nearer points. In 1887 the San Antonio and Aransas Pass Railroad, from Houston to San Antonio, was built through the county and afforded better shipping points and railroad connections.

Corn was the first and principal crop grown by the early settlers. Some sorghum for molasses, sweet potatoes, and other vegetables, pork, milk, and butter were also produced for home consumption. Cotton was grown to some extent from the first, and soon became a staple crop. By 1860, 5,000 bales were being produced in the county. Horse gins were used, but just prior to the civil war a few steam-power gins were introduced. Port Lavaca, the nearest shipping point on the Gulf, was the cotton market until the railroad was built. Transportation was by wagons drawn by oxen, and the traffic was sufficient to engage many men in this work.

Until barbed wire came into use in the county about 1870 for fencing purposes, it was considered unprofitable to put much land under culivation because of the great expense, even in the timbered portion of the county, of erecting and maintaining wooden fences to protect the crops from the herds that had free range of the whole country. With the use of barbed wire, fencing could be done easily and economically. Some prairie lands, occupied by the German and Bohemian settlers, were fenced and put under cultivation mainly to cotton. The production of cotton, however, declined from 1860 to 1870, and there was increased attention given to stock raising, due no doubt to the changed local conditions prevailing during and immediately after the civil war. But in the next decade cotton again became a favorite crop, and by 1880 the production was double what it had been before the war, its acreage being nearly as large as that devoted to corn. On the other hand, the number of cattle in the county had decreased one-fourth since 1870. At this time sheep raising had become an industry of some importance, and there were more than half as many sheep as cattle of all kinds. Sheep raising, however, in a few years declined, and continued to do so, until now only a very few are raised in the county. During the next twenty years, from 1880 to 1900, the cattle industry grew in importance along with the increased production of cotton, the census figures showing that there were more cattle in the county in the year 1890 and also in 1900 than there had been at any time except in 1870. In this connection it is interesting to note that the increase was more largely on the small farms than on the ranches, and was not accompanied by a decline in cotton growing. In 1890 the value of the cotton crop was equal to one-half of the estimated value of all the farm products of the county for that year. But in the last few years the production of cotton has been greatly decreased by the ravages of the boll weevil, and there seems to be at present a manifest tendency toward a diversification of crops.

CLIMATE.

The appended tables, taken from the records of the Weather Bureau stations at Hallettsville, Cuero, and Rock Island, give the normal monthly and mean annual temperature and precipitation, and the occurrence of the last killing frost in spring and the earliest in fall. The figures represent fairly well the climatic conditions of the area. As will be seen from the table the average annual mean temperature is about 69° F. for all the stations. The average temperature for the winter months is about 17° lower than the average annual mean temperature, while for the summer months it is about 15° higher. The extreme annual range in temperature is about 80° F. The maximum is very close to 100° F., while the minimum may go as low as 20° or 15°. Some sudden changes occur during the winter, when cold waves from the north reach down into this section. Starting with a cold north wind, there may be a change in temperature in an hour or two of 30° or more. These cold winds, known as "northers," are of short duration, lasting rarely more than three days. There is seldom any snowfall, but occasionally during the prevalence of a "norther" there may be a few snow flurries.

Situated near the Gulf, with prevailing southerly winds throughout the year, Lavaca County has a moderate and rather equable climate. In the warmest weather the cool Gulf breezes moderate the heat so that it is not oppressive, and the nights are cool and pleasant. By reference to the table showing occurrences of killing frosts it will be seen that the growing season for crops liable to damage by frosts is nearly nine months, but for those that can withstand somewhat lower temperatures it extends throughout the year.

In east Texas the annual rainfall exceeds 40 inches, but it decreases westward in the State to less than 10 inches. The rainfall in Lavaca County is a mean between the heavier precipitation to the east and the semiarid condition to the west, it being between 30 and 40 inches. How rapid these changes are will be noted in the difference in rainfall at Rock Island and Hallettsville, the difference being about 9 inches, although Rock Island is only about 25 miles east of Hallettsville.

The average rainfall of the county is ample for farm crops, and is well distributed throughout the year.

Normal monthly and annual temperature and precipitation.

Month.	Hallettsville.		Cuero.		Rock Island.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	*Inches.*	*° F.*	*Inches.*	*° F.*	*Inches.*
January	52.3	2.85	52.7	2.37	52.0	3.08
February	53.7	1.85	53.6	2.10	50.5	1.79
March	63.5	1.79	63.3	2.09	63.2	2.40
April	70.3	3.08	70.3	2.82	66.0	4.20
May	76.8	3.82	77.3	3.14	76.0	3.52
June	82.0	3.92	82.7	5.49	81.6	4.82
July	84.0	2.09	85.0	2.14	82.7	3.87
August	83.7	2.39	84.8	1.66	83.4	2.64
September	79.4	3.38	79.1	4.52	78.7	4.06
October	70.7	2.74	71.1	3.03	71.6	2.76
November	61.3	2.58	61.7	2.61	62.5	5.07
December	53.8	2.43	54.2	2.05	53.5	3.13
Year	69.3	32.40	69.7	34.02	68.5	41.34

Dates of first and last killing frosts.

Year.	Hallettsville.		Cuero.		Rock Island.	
	Last in spring.	First in fall.	Last in spring.	First in fall.	Last in spring.	First in fall.
1896	Feb. 15	Nov. 28	Feb. 15	Nov. 8		
1897	Mar. 24	Dec. 4	Feb. 1	Dec. 4		
1898	Mar. 5	Nov. 22	Mar. 5	Oct. 27		
1899	Mar. 29	Nov. 3	Mar. 6	Nov. 4	Feb. 12	Nov. 3
1900	Mar. 1	Nov. 12	Feb. 19	Nov. 12	Feb. 19	Nov. 12
1901	Mar. 6	Dec. 10	Mar. 5	Dec. 10	Apr. 6	Dec. 9
1902	do	Dec. 5	Mar. 6	None.	Feb. 21	None.
1903	Feb. 18	Nov. 18	Feb. 19	Nov. 18	Feb. 17	Nov. 18
Average	Mar. 6	Nov. 24	Feb. 24	Nov. 16	Feb. 27	Nov. 18

PHYSIOGRAPHY AND GEOLOGY.

The surface of Lavaca County changes gradually from flat to rolling as one goes from south to north and as the elevation increases. The elevation of the coastal prairie above sea level probably does not exceed 100 feet. The highest elevation within the county is on the high rolling prairie in the vicinity of Moulton on Burkett Mound, which is 500 feet above sea level. Halletsville, with an intermediate location, has an elevation of 235 feet.

The extreme southern part of the county is occupied by a flat treeless prairie, which is an extension of the Gulf Coastal Plain. It has a gradual rise from the Gulf, probably not over a foot or two to the mile. In wet times it is covered by water, which does not pass off because of lack of surface drainage. Next to this prairie is a timber belt, which extends northward to a little above the central portion of the county, crossing the county in a southwesterly direction and occupying a large part of its area. The topography of this section is flat to rolling. The southern portion adjacent to the treeless prairie is flat like the prairie and is also wet and lacks surface drainage. It, too, gradually increases in elevation, and the section to the north becomes more rolling and connects with the higher prairie. Its elevation is sufficient for stream erosion and the surface is somewhat dissected. The slopes to streams are long and gentle and rarely steep. The interstream portions are broad and flat or gently rolling. The characteristic growth is post oak, from which the soil has become popularly known as " post oak land."

The northern part of the country is much higher and more rolling and is a part of what is known as the Fayette Prairie, and here popularly called " black prairie." The dividing line between the black prairie and the timber or post oak land is followed approximately by the railroad across the county. The black prairie consists of a succession of broad, rolling ridges having an easterly to southeasterly trend. The slopes of these are, as a rule, long and gentle, except in the western and northwestern part, where they are somewhat steeper and the tops of the ridges not so broad. The ridges rise about 100 feet or more above the intervening troughs or valleys. The black prairie is treeless, with the exception of a fringe of liveoaks along some of the streams and an occasional clump of small trees on some of the sandy knolls which occur in the formation. Areas of post oak land extend to the eastward into this section and are covered by the characteristic growth. The succession of ridges with green pastures and cultivated fields interspersed makes a most pleasing landscape.

The drainage of Lavaca County is effected by the Lavaca and Navidad rivers and their numerous tributaries. Navidad River drains the eastern part of the county, having its source in Fayette County to the north. Lavaca River flows through the central part and drains the western two-thirds of the county. The drainage is toward the south or southeast. Most of the streams head in the black prairie, and the surface configuration is such that surface drainage is effected easily. During heavy rains the water flows off so rapidly that even little branches become raging torrents, but as soon as the rain ceases the streams fall almost as rapidly as they rose. The smaller streams carry water only during wet times, and even the larger ones become dry or nearly so in prolonged periods of drought. The streams are rather rapid flowing, having a good fall through the county. They are still cutting their channels and no flood plains are being formed. During high water they carry large quantities of soil materials.

Geologically, Lavaca County is included in the Gulf Coastal Plain. In Cenozoic time this portion of Texas was covered by an extension of the sea, whose waters then extended much farther northward.

From the lands to the north, gravel, sand, silt, and clay were carried down by the streams and deposited in this sea. At a later time the earth's surface was elevated above sea level, and these vast deposits, subject to the agencies of weathering and erosion, have since been modified to form the present soils. Since these deposits were laid down, sufficient time has not elapsed for their consolidation, but there is to be seen, however, along some of the stream courses in the higher and older parts of the county occasional outcrops of loosely consolidated sandstone, locally called "rotten rock," or "rotten sandstone." In the black prairie section limy material is found in the subsoil, occurring in the form of concretions averaging an inch or two in diameter, and occasional small knobs are made up of these concretions. Limy material is also present to a less extent in the mottled clay subsoil of the lower parts of the county. All the clays are more or less calcareous. The origin of the lime is found in the remains of marine life accumulated with the deposits of rock material.

The soils are the more or less weathered product of the different sediments or deposits. The larger part of the surface of the county is covered by sand of medium to fine texture and of varying depths, underlain by drab and yellow mottled sandy clay, occasionally reddish, quite impervious, and extending to an unknown depth. The soil of the black prairies is a black waxy clay, which at a foot or more beneath the surface changes to drab because of the lower organic matter content and the presence of limy material.

SOILS.

Only three types of soil are found in Lavaca County, and as two of these—the Lufkin sandy loam and Lufkin sand—are separated on the difference of the depth of the sand covering the sandy clay subsoil, the entire surface of the county is occupied by soils belonging strictly to two classes—sand and clay. There is thus little variety in soil types, although there is the greatest difference in the character and agricultural value of the types found.

The following table gives the names and extent of the different types, all of which have been found in other parts of Texas already surveyed.

Areas of different soils.

Soil.	Acres.	Per cent.
Lufkin sandy loam	357,632	56.2
Houston black clay	215,232	33.8
Lufkin sand	63,936	10.0
Total	636,800	

LUFKIN SANDY LOAM.

The soil of the Lufkin sandy loam consists of medium or fine sand, varying in texture from an incoherent sand through loamy sand to sandy loam, and in color from gray to dark brown, depending largely upon the amount of organic matter present. In some places where this soil borders the black prairie it is much more loamy and darker in color. Here it represents a zone of gradation between the Lufkin sandy loam and the Houston black clay rather than a distinct type, the change from one to the other being very gradual and covering a considerable area. In the flatter areas the soil becomes quite compact, but in texture does not depart from the main type, the difference in structure being due to a difference of condition rather than to a difference of mineral particles. The depth of the soil varies greatly over the county and within narrow limits. It ranges from 8 to 20 inches, and this variation may be found within any given field. The average for the county, however, is about 14 inches.

The subsoil consists of a drab and yellow mottled sandy clay, sometimes one and sometimes the other color predominating, often streaked with iron stains. In places it is an even yellow or red, but the occurrences are in small areas. The sand particles in the clay are of the same sizes as in the soil—that is, medium to fine, with a much larger percentage of the fine sand. It is a stiff, tenacious, impervious clay. Ponds or tanks dug in it retain water, and water falling on the surface is held and is lost through evaporation rather than percolation. Its water-holding capacity is high and the clay is always found in a moist condition. It erodes badly where the slope is sufficient, and deep gullies are quite common. The depth of the clay is unknown, extending beyond the ordinary means of observation as shown by exposures in road and stream cuts. It is more or less calcareous, and occasionally some lime concretions are seen. Iron concretions, but in no great quantity, occur in both soil and subsoil, and occasional thin beds of gravel.

The Lufkin sandy loam occupies more than one-half of the total area of the county. It occurs in the southern part of the county in practically one continuous area, and in the northern part in several smaller irregularly shaped areas interspersed through the Houston black clay. The topography is flat to rolling. In the southeastern corner of the county and the extreme southern corner the type occupies the flat treeless prairies, one known locally as the " Golden Rod Prairie," and the other as the " Victoria Prairie," or in general as " Sandy Prairie." North of these prairies this type of soil is still largely forested. The wooded areas next the prairies are generally flat, but to the north the topography becomes more rolling, and the larger part of the type has the latter character of surface. In the northern part of the county it occupies the tops of the ridges in the high rolling prairie and slopes to the stream courses. The slopes to the streams are usually gentle, but occasionally they are steep. The interstream areas are flat to gently rolling.

Wherever the surface is rolling the drainage is good, there being plenty of stream courses to carry off the water, but the flat interstream areas and the low-lying portions of the southern part of the county lack drainage, and the subsoil being impervious the water stands on the surface for some time after rains. These flat areas are, therefore, in their present condition, unfit for cultivation, but do fairly well for pasturage. All the larger streams of the county flow through this soil type, and many have their sources in the northern parts, although the greater number of streams head farther north in the Houston black clay.

The Lufkin sandy loam is derived from the weathering of Gulf Coastal Plain deposits, consisting of unconsolidated sands and clays.

This type supports a forest growth, consisting largely of post oak with some black-jack oak, and, along the streams, liveoak. The post-oak growth is not heavy, nor is it large, attaining a height of not more than 40 or 50 feet. Rarely more than one cut can be taken for posts, as above that the trunk and limbs are twisted and gnarly and of no use except for fuel. From the limbs hang long masses of gray Spanish moss, and when completely covered with it the tree in time is killed. The Spanish moss serves a good purpose in that stock will eat it when other food is not available. In winter when food is scarce the trees are cut down to enable the stock to get the moss.

The principal crops grown on the Lufkin sandy loam are cotton and corn, the staple products of this section of the State. Cotton, however, is the crop to which the most attention is paid. It succeeds well on this soil, the yields being from one-half to three-fourths bale per acre in favorable seasons, and even as high as 1 bale or more in exceptional cases. These yields are secured without the use of any fertilizer whatever. The land is easy to till and responsive, and produces a good grade of fiber. Corn does not do so well as cotton, except on the lower slopes near streams, where the soil is deeper and more loamy. The corn grown is mostly a white dent variety, and the average yield is from 15 to 18 bushels per acre, although higher yields are secured on the best lands. Sorghum is grown and does well on this soil, and ribbon cane also in the more loamy and richer places along the streams. Quite a large quantity of the former is grown for forage and some for sirup.

Last season the growing of tobacco and truck crops was begun on this soil. The tobacco grown was a Cuban filler leaf, yielding about 600 pounds to the acre. There was also produced some Sumatra wrapper leaf. The adaptability of this soil to the growing of the

Cuban filler leaf of the desired quality can not be positively stated as yet.

The Lufkin sandy loam is unquestionably well adapted to truck crops. The past season early Irish potatoes succeeded very well and proved quite profitable. The average yield was between 75 and 100 bushels, but larger yields should be obtained when the growers become more familiar with the methods of growing this crop. The Tennessee Triumph, a red variety, succeeds best, and to get an early crop northern seed, from Maine and Minnesota, is used. Onions were also grown, and the acreage is increasing. This season a large acreage will be planted to cucumbers for pickling purposes. Tomatoes and beans also do well on this soil, and some will be produced for shipment.

The size of the farms of this type of soil ranges from a few acres to ranches of several thousand acres, the latter being stock ranches. The average value of the land is about $10 an acre. Land near the towns and the railroad brings $25 or more, while in the lower part of the county it is as low as $2 an acre. The value of the large ranch tracts depends upon whether there is flowing water upon them.

All of the Lufkin sandy loam not under cultivation is fenced for pasture. The soil supports a growth of sage and mesquite grass, and about 8 or 10 acres is required for each animal pastured.

The results of mechanical analyses of samples of the soil and subsoil of this type are given in the following table. The figures are the average results for two samples each of soil and subsoil.

Mechanical analyses of Lufkin sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
12992, 12441	Soil	0.2	4.5	11.0	49.8	16.1	12.3	5.7
12442, 12993	Subsoil	.2	3.3	8.1	31.9	9.3	12.1	34.7

LUFKIN SAND.

The Lufkin sand consists of a loose, incoherent, gray, medium to fine sand, with the surface foot having organic matter enough to give it sometimes a brownish color, the lower portion being gray to yellowish in color. The depth of the soil usually exceeds 36 inches. Beneath the sand is found the same drab and yellow mottled sandy clay that forms the subsoil of the Lufkin sandy loam. In fact, the only distinction between the two types is the difference in depth of sand overlying the clay and the consequent difference in agricultural value. In some places, however, the clay comes to within 24 inches of the surface.

The Lufkin sand has the least extent of the three soil types found in the county. The largest area is in the eastern part of the county, extending from Sublime down the Navidad River to Vienna and eastward to the county line. Another considerable area occurs between the Navidad and Lavaca rivers to the west of Vienna. Other smaller areas are scattered over the county as spots in the Lufkin sandy loam.

The type occupies the sandy ridges in the post-oak section of the county, and also occurs as narrow areas along some of the streams. In the vicinity of Sublime and south and eastward the surface is quite flat and the depth to the clay is not so great. The soil readily absorbs water, and its location on ridges insures thorough surface drainage.

The Lufkin sand is of sedimentary origin, and is derived from a Coastal Plain formation consisting of loose, incoherent sands. Like the Lufkin sandy loam it supports a forest growth of post and blackjack oak and some liveoak in moist locations, but there is more blackjack than on the Lufkin sandy loam and it is sometimes called "blackjack land." It is a poor soil and but little of it is cleared and under cultivation. Crops grown upon it usually suffer from lack of moisture, but in favorable years when rainfall is plentiful fair crops of cotton are obtained. This soil seems best suited to sweet potatoes, which are of excellent quality, and with a good market they would no doubt prove a profitable crop. Early trucking crops might also do well.

The average results of mechanical analyses of typical samples of the Lufkin sand are given in the following table:

Mechanical analyses of Lufkin sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
12990, 12986	Soil	0.4	9.6	19.3	54.9	8.3	4.5	2.8
12991, 12987	Subsoil	.5	8.7	20.1	54.6	8.4	4.3	3.3

HOUSTON BLACK CLAY.

The soil of the Houston black clay varies from a heavy loam or clay loam to a stiff waxy clay, but consists largely of the latter phase, to which the names of "hog wallow" and "black waxy" land, or the more general term "black prairie," have been locally applied. The first name refers to the numerous shallow holes or depressions in the surface, resembling wallowing places made by hogs, but due entirely to natural causes not understood. The latter names re-fer to the black colored and waxy character of the clay. The soil ranges in depth from 8 to 20 inches, with an average of about 12 inches, and in color is generally black, although small areas or spots occur where the color is drab or grayish black. These spots are usually found in the cultivated fields. The soil carries a high percentage of organic matter, which no doubt accounts largely for its color.

In places on the rolling prairie and on lower slopes toward some of the streams, particularly along borders of the sandy types of soils, there are varying amounts of sand on the surface, from a trace to as much as 3 or 4 inches in depth, which when incorporated with the black clay by plowing gives the loamy phase of the type, making it lighter and more friable. This is spoken of as "heavy black sandy loam" or "heavy loam." These areas, however, are small and the condition may be considered a gradation between the black clay and sandy loam soils. Areas with the sandy character sufficiently pronounced and large enough to map were placed with the Lufkin sandy loam, differing but little from that type of soil, especially in its more loamy phases.

The subsoil of the Houston black clay is a stiff, very tenacious waxy clay, generally some lighter in color than the soil, because of lower organic matter content, and gradually becoming still lighter in color with depth, varying from yellowish to drab. Sometimes, however, the color in narrow streaks or pockets becomes reddish, and often there is a succession of the different colors, black, yellow, red, and drab, as seen exposed in road cuts. In the subsoil and occasionally in the soil occur lime concretions, the quantity generally greater in the lower depths, making the subsoil so much lighter in color that the name of "chalky clay" is often given to it. Occasionally also some iron concretions are seen in the subsoil and on the surface.

The extent of the Houston black clay is next to that of the Lufkin sandy loam, or fully one-third of the area of the county. Its principal development is in the northern part of the county above the line of the railroad, where it occurs practically in one large area with but few interruptions. Small isolated areas are scattered over the southern part of the county.

The topography of the Houston black clay consists of flat to high rolling prairies. In the southern part of the county the areas are flat, while the northern area consists of a series of broad rolling ridges having a southeasterly trend, with an average elevation of nearly 400 feet. The slopes as a rule are long and gentle, but are a little steeper in the northwestern part, which forms a divide between drainage basins to the east and west.

The lower and more level areas lack surface drainage, and having an impervious clay subsoil are wet the greater part of the year. In the higher areas the rolling character of the surface insures rapid surface drainage. Many streams head in the high prairie, but only a few carry water the whole year. For watering the stock wells are dug and water lifted by windmills. Water is found in a sandy stratum beneath a stratum of joint clay.

The Houston black clay is derived from the weathering of a Coastal Plain deposit consisting of a calcareous clay, the lime occurring in the form of concretions. The only rock found in the county occurs in this formation and is a loosely consolidated sandstone, outcrops of which are seen in road and stream cuts.

The Houston black clay is the most valuable soil in the county for the staple crops, and farms of this soil are the highest in price. It is treeless, with the exception of a fringe of live oaks along the stream courses and occasional clumps of small trees growing on the sandy knolls. It is all settled and divided into farms, which are being further subdivided into smaller farms. The farms are owned almost exclusively by German and Bohemian farmers, who are industrious and thrifty. The crops grown are cotton and corn. Cotton yields from one-half to 1 bale to the acre. It has always been the principal crop, and before the appearance of the boll weevil it was possible for a farmer to purchase a farm with borrowed money and be able to clear himself of debt in a few years. Corn does fairly well on this soil, producing from 25 to 50 bushels per acre. For corn the lower locations are best, where the soil is more loamy and better moisture conditions prevail. Some onions are grown on this soil and good yields are obtained. Irish potatoes are grown on some of the lighter phases, but they do better on the sandy soils. Sorghum and millet are grown for forage and give large yields. Alfalfa has succeeded on a similar soil in other parts of the State, and if grown here would prove a most profitable forage crop and a soil improver as well. The cowpea is another legume which should be extensively grown, as it no doubt will thrive here. The growing of these legumes, aside from being profitable as forage crops, would afford a desirable step in crop rotation, thus eliminating the necessity of keeping so much land in permanent pasture. Under present methods a large part of each farm is left in the native prairie pasture, consisting of sage and mesquite grasses, which make a strong growth on this soil. Some is cut for hay, but the larger part is pastured. About 4 acres is allowed for each animal, which is about one-half that allowed on the sandy soils.

The value of the farms located on the Houston black clay ranges from $25 to $50 an acre. At the present time, however, these farms are not on the market even at the higher price.

The average results of mechanical analyses of samples of the soil and subsoil of the Houston black clay are shown in the following table:

Mechanical analyses of Houston black clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
12984, 12982	Soil	0.0	0.7	2.0	12.3	5.1	24.4	55.3
12985, 12983	Subsoil	.1	.6	1.7	9.0	4.2	26.4	57.5

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12982, 2.93 per cent; No. 12983, 6.45 per cent.

AGRICULTURAL METHODS.

Lavaca County, unlike most of the cotton-growing sections of the South, has a diversity of interests on nearly every farm, in that stock raising is practiced in connection with the cultivation of staple crops, each interest being conducted independently of the other, thus differing from those sections in which the raising of stock is included in the general farming operations only as a factor in the rotation of crops and the improvement of the soils. In Lavaca County the farmer raises stock because his lands naturally afford good pasturage, and from the sale of cattle or other live stock he has an income independent of his farming operations. On every farm, large or small, may be found cattle and hogs. This necessitates the leaving of a large part of the farm in pasture, and in the southern part of the county ranches of several thousands of acres are devoted entirely to the grazing of cattle. On the smaller farms stock cattle are generally kept, while the ranches are used mostly for range cattle. Yearlings and 2-year-olds are bought up and put on the ranges and pastured for a year or two and then sold and shipped to the northern part of Texas and to Oklahoma, where they are pastured before marketing for beef. Some cattle are fattened here on cotton-seed meal and hulls, but the greater number are shipped farther north each spring for pasturing and preparation for the fall market. Throughout the year cattle are made to depend almost entirely on the range for sustenance and are without shelter of any sort; consequently during a severe "norther" many are lost. When feed is scarce on the range it is common practice to cut down trees covered with Spanish moss, which the cattle will eat when there is nothing better. At times it is found necessary, in order to bring them through the winter, to feed them cotton-seed meal or hulls.

The cattle are largely the native Texas breed of Spanish origin, but somewhat modified by the introduction of some Shorthorn and Hereford blood. They are kept because of their hardiness and adaptability to the range. Grading up the stock still more with good beef breeds will improve it in both size and quality. The increasing prices of land and the more exacting demands of the markets make this improvement not only desirable but necessary, and a little more attention to sheltering stock in the most inclement weather and supplying fodder during a few of the coldest weeks of the winter will result in raising a better class of beef animals and securing more profitable returns than were realized under the methods that succeeded in the days of the open range and low-priced lands. The hogs raised are well graded up with improved breeds, and the corn grown not used for feeding the working stock is turned largely into pork.

Although a large part of the land is left in native prairie grass for pasturage, only a small area is cut for hay. This supply of forage is supplemented by the growing of sorghum and millet and curing them for winter feeding. No cultivated grasses or legumes are grown, the former not succeeding here as yet, while the latter have not been tried, although cowpeas and alfalfa would both do well, the cowpeas especially.

In the production of cotton and corn the methods followed are those generally practiced in the South. These crops are grown on ridges and without any previous preparation of the soil for the planting of a crop, except that involved in throwing several furrows together to make the row or ridge. The method is to throw two furrows together with a turning plow late in the fall or in the winter, and then in the spring before planting to complete the ridge by breaking out the middles between the ridges by a plow with wings, commonly called a "lister." The following year this ridge is turned and what was the furrow the preceding year is now the ridge, and this is continued year after year, alternately moving the furrow and ridge. The corn or cotton is planted in a furrow on top of the ridge.

The corn-planting season is from February 15 to March 15. The furrow in which it is planted is made deep in the ridge and the result of the first cultivation is to make the ground level, but in the cultivation after that larger shovels are used and the earth is thrown to the corn, so that the corn finally stands above the general level of the field. The cultivation in ridges causes a great loss in moisture by exposing a larger surface to the drying action of the sun and wind, and it would be much better, therefore, to cultivate as level as possible to prevent this loss, although it may be desirable and necessary to ridge the soil at first so as to get it in the right condition for planting. As corn is considered a crop of secondary importance it is not so well tilled as cotton, the farmers rarely giving more than two cultivations and one hoeing in which the corn is thinned. As a consequence the fields become weedy and in a few years it becomes necessary to grow cotton, which is given clean cultivation, to kill off the weeds. The corn is harvested by breaking off the ear from the stalk and storing in cribs without shucking. The shucks protect the corn from dirt and the attack of weevil. Some difficulty is experienced in saving corn or any grain from the weevil, but with corn this loss is lessened or prevented by growing the corn as early as possible and storing as soon as matured.

The planting of cotton is done about one month later than corn. Unlike corn, it receives careful attention and clean cultivation. The number of times it is cultivated depends upon the season, but it receives at least three cultivations and two hoeings. The boll weevil in this section has become a very serious pest, and farmers are fortunate to get even small yields, for often the weevil ruins whole fields and there is not much cotton to pick. To combat the ravages of the boll weevil both the National and State authorities have recommended early planting, the use of earlier maturing varieties, the forcing of maturity by proper cultivation and fertilization, and, finally, the destruction of the stalks immediately after the crop is harvested. This last suggestion is not generally complied with in this county. The effect of the pest has been to turn the attention of the cotton growers toward a diversification of crops.

Although corn occupies about two-thirds as great an acreage as cotton, no systematic rotation is followed. Each is grown continuously on the same fields, and, as before stated, the only change made is to grow cotton after several crops of corn so as to destroy the weeds. No fertilizers of any sort have been used with either of these crops on any of the soils, as it is said they have shown as yet no appreciable decline in productiveness. That the soils have not decreased in productiveness is due mainly to the comparatively short time they have been tilled. However, if the present crop yields are to be increased or even indefinitely maintained, fertilization, preferably by means of barnyard manure or the use of green manuring crops, and systematic rotation with the best methods of cultivation must be practiced. A greater diversification of crops is also recommended.

AGRICULTURAL CONDITIONS.

The interests of Lavaca County are entirely agricultural, and in agricultural wealth it holds a prominent place among the counties of this section of the State. This is due to two factors—the productiveness of its soils and the generally industrious and thrifty character of its people. The farmers, however, like those in some other sections in which cotton is the main crop, have been passing through a period of depression, due chiefly to the boll weevil, whose ravages have been most serious in this part of Texas. The small farmers and tenants, depending entirely on cotton as a means of livelihood, have felt the loss most keenly. The whole community, in fact, has suffered, the merchant as well as the farmer. Prior to the advent of the boll weevil it was not an unusual thing for a farmer to buy and pay for a farm in a few years with cotton alone, even though the prices had not been the best. It can be said, too, that stock raising does not pay as well as it did formerly. With the low-priced lands and the free range of early days the raising of cattle was very profitable, but with the increased value of land, the low price of beef on the hoof, and the more exacting demands of the markets, together with the scarcity and increased cost of labor, this industry does not give the profits it once did.

Although the present conditions seem unfavorable they will no doubt prove beneficial in the end by bringing the attention of the people to the necessity of diversifying their crops and improving their cultural methods. A case in point is the introduction within the past two years of two new industries into this section—the growing of tobacco and trucking. The latter now promises to become of great importance, certain truck crops having already brought about a change for the better in parts of the county.

The cultivation of field crops is confined mostly to territory along the railroad on the sandy soils, and to the black prairie occupying the northern part of the county.

The Houston black clay of the prairies is the strongest and most productive soil of the county for general farming, and consequently the farms on the prairie are the most desirable and have the highest value. The farms are fenced and in a fair state of cultivation. The dwellings are small, but comfortable; and the outbuildings, as a rule, are also small. On account of the mild climate no shelter is provided for the stock, excepting the work animals. On a large number of farms windmills are used to pump the water for the stock, and many have storage tanks at an elevation to supply water to the houses. The owners are almost exclusively Germans and Bohemians, who, with the aid of their families, work the land without recourse to hired labor, and whose success is largely due to industry and strict economy. On all the farms cattle are kept, and this necessitates the leaving of permanent pastures. The farms on the Houston black clay are the smallest in size in the county, averaging about 100 acres. Before the introduction of barbed wire much of this land could be bought as low as 25 cents an acre; but the use of barbed-wire fencing made it possible to fence it cheaply and to cultivate to crops, and since that time its value has been increasing, prices now ranging from $25 to $50 an acre.

The sandy soils of the county do not have as high a value as the black prairie, but if the growing of tobacco and truck crops or either of these interests develop to large proportions these lands will be in great demand, with corresponding increase in values. When the county was settled and until the barbed-wire fence came into use these lands were held at a much higher price than the black prairie, because the timber afforded material for building purposes, fencing, and fuel.

The soil was easy to cultivate and made fair yields of the staple crops, cotton and corn, particularly the former. The larger proportion of the sandy lands is now in large ranches devoted to grazing. With the successful introduction of the new industries mentioned there is promise of more remunerative returns from the sandy types of soil.

According to the census of 1900 there were 3,876 farms in Lavaca County, with an average size of 134.1 acres, but the land holdings vary greatly in size, ranging from places of only a few acres to ranches of several thousand acres, the larger holdings being generally in the more remote parts of the county. According to the same authority, of the total acreage in farms only about one-third is improved, and of the total number of farms 44.7 per cent are operated by the owners. Foreigners, particularly the Bohemians, and some negroes, form the tenant classes, as they lack the capital necessary to purchase land, and as they prefer to work the black prairie lands, which are high priced and not for sale, but can be rented. The tenants as a rule devote themselves to the staple crops, making enough corn if possible for their needs and cultivating as large an acreage of cotton as possible, depending upon it as their money crop. With small yields, on account of the damages of the boll weevil, even with the prevailing prices, cotton growing has certainly not been as remunerative as formerly, and in some cases the tenants have suffered greatly, and the landowners also, though to a less extent. Renting is done on both the share and cash basis. The general rule is to pay cash for corn land, the usual rental being about $4 an acre. Cotton before the weevil became a factor was also grown on a money-rent basis, but now the share system is used exclusively, so that the owner as well as the tenant may share in the uncertainty of the crop. The rule is to give the landowner one-third of the cotton where the tenant furnishes everything except the land, but when the owner furnishes the working stock and tools and half the seed he gets half of the crop. The tenant is allowed a house with ground for garden and also a limited amount of stock in the pastures. Ranch lands are leased for a nominal money rental for a number of years. The value of the ranch lands is low, varying from $2 to $10 an acre. As a rule the ranch owner does not live on the ranch. A foreman superintends the work, having under him a number of men to help care for the stock, who receive some wages in cash and are allowed to cultivate small patches of ground to aid in their support. There is but little hired labor employed except on the ranches.

In 1899, according to the last census, the acreage in cotton in the county was about 80,000 acres, with an average yield of something over one-half bale to the acre. Since that time the production has fallen off greatly owing to the ravages of the boll weevil, as has been heretofore explained.

The acreage in corn in 1899, according to the census, was about five-eighths that in cotton, with a yield of a little over 1,000,000 bushels. The yields could be greatly increased if better cultural methods were practiced and a suitable crop rotation followed. The small grains do not succeed in this climate, although small patches of wheat, oats, and rye are often seen. No rice is produced in the county, although the black prairie land in the southern part of the county, with irrigation, is well suited to this crop. Cowpeas would thrive on the soils of this county and, besides being an excellent forage crop, would prove beneficial to the soil if given a place in the crop rotation. Alfalfa would also probably do well, and prove a most valuable forage crop. The millets and Hungarian grasses are grown with success. Sorghum forms the most important forage crop, and is valued also for the sirup produced. Sugar cane is grown on the bottoms and some sirup is made. A forage crop that might prove of value is teosinte, small experiment patches of which were seen. Sweet potatoes are grown on the sandy soils in sufficient quantities for home consumption. If an outside market could be found, this crop would be a profitable one. The Lufkin sand is particularly adapted to the growing of sweet potatoes, which are of superior quality. Of the small fruits, strawberries succeed the best, but are grown only to meet the small local demand. Blackberries are produced, but are subject to rust. Of the tree fruits, pears do fairly well, but the trees are often subject to blight. Apples and peaches do not succeed. The fig tree grows here, but the quantity of the fruit is limited to home consumption. The pecan tree is a native of this part of Texas. The trees are plentiful, and quite a large quantity of pecans is obtained. These are all shipped to outside markets, where good prices are received.

As has been stated elsewhere in this report, the farmers are beginning to give some attention to truck crops, to which the sandy types of soil are well adapted. Irish potatoes were the first crop to be given a trial and have proved profitable. The product can be put on the northern markets early in the season, when good prices generally prevail. The acreage is rapidly increasing and the product is becoming important. Onions also have proved a profitable crop, and the acreage in this crop is increasing. Tomatoes are being grown, and a large acreage is to be devoted to cucumbers for pickling purposes. Beans and a few other vegetable crops are to be grown in quantities sufficient for shipment. To promote the trucking interests a number of truck growers' associations have been organized in the county, the main purpose being to give instruction to the farmers in growing the crops and to assist in disposing of the products to the best advantage.

The growing of tobacco has not been taken up so readily by the farmers, because of the lack of knowledge of the proper methods in cultivating, harvesting, and curing the crop. Some effort is being made to produce a Cuban cigar-filler leaf. In the season of 1904 about 20 acres were cultivated, producing about 12,000 pounds. This acreage was owned by a local company organized for the purpose, and the tobacco was grown under the direct surpervision of an experienced tobacco grower from another State. There was also grown less than an acre of Sumatra wrapper leaf under shade. The tobacco the past winter was manufactured into cigars, using the home product, filler and wrapper, entirely in the manufacture. The cigars have met with a ready sale and an increasing demand, the market thus far being confined to the surrounding towns. The quality of the tobacco can not be definitely stated, as the leaf of which the cigars were made had hardly been fermented long enough, but if the Cuban aroma is found and can be brought out by fermentation, then the success of tobacco growing ought to be assured.

The transportation facilities of the county are fairly good. The main line of the Southern Pacific Railroad passes a few miles north of the county, and a branch line of the same road passes through the county to the south. The San Antonio and Aransas Pass Railroad traverses the central part of the county from east to west, connecting Houston and San Antonio and also Port Lavaca and other points on the Gulf, and a branch line of this road crosses the northern part of the county, connecting Yoakum and Waco. The San Antonio and Aransas Pass system affords direct connections with all the trunk lines to the east, north, and west.

The county roads are generally poor. Over the black prairie during the winter they often become impassable, but during the summer the surface material wears down smooth, making an excellent roadway. These roads could be greatly improved by cutting ditches on the sides to drain them. The roads in the section of sandy soils with clay subsoils could be made the best in the county by surfacing them with clay or making what is known as a sand-clay road. There are, however, a sufficient number of roads laid out and all are straight. In the more remote parts of the county the roads are mere trails. But few bridges, and these only over the larger streams, are maintained in the county.

The local markets are limited and take only the staple products. The truck crops are shipped mainly to St. Louis and Chicago. Truck buyers, however, are coming to this section of Texas and the growers are being relieved of the responsibility of shipping.

Poultry and eggs are important local products and the shipments are steadily increasing, adding considerable to the farm income. Yoakum leads in this part of Texas as a shipping center for poultry products.

The rural free delivery service is being extended gradually over the county, and a few rural telephone lines have been built and are now in use.

SOIL SURVEY OF HENDERSON COUNTY, TENNESSEE.

By **M. EARL CARR** and **FRANK BENNETT.**

LOCATION AND BOUNDARIES OF THE AREA.

The State of Tennessee is divided geographically into three parts—West Tennessee, Middle Tennessee, and East Tennessee. Henderson County is situated in the eastern part of West Tennessee, only a short distance from the Tennessee River. It is bounded on the north by Carroll County, on the east by Decatur County, and on the south by Hardin County. Chester County lies to the southwest and Madison County to the west. All the boundaries are regular, except that on the Chester County side, which takes a circular direction to the southwest until it reaches the South Forked Deer River, about 3 miles east of the Madison County line.

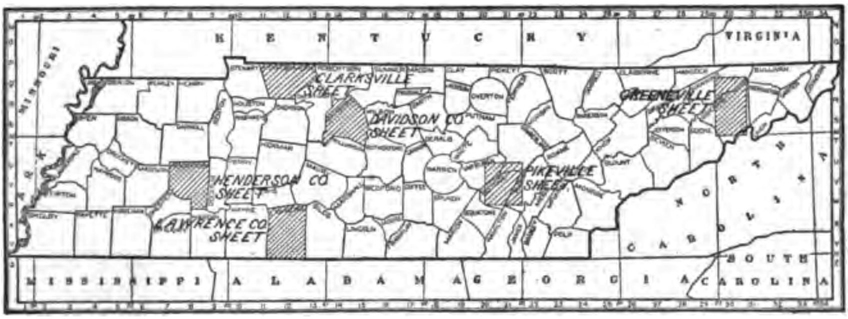

FIG. 26.—Sketch map showing location of the Henderson County area, Tennessee.

The base map used was traversed by the party in the field as the mapping of the soils progressed. No notes or maps of the county lines were available; therefore they were located in the field from information secured of the farmers living near them.

The greatest extent of the county north and south is 28 miles and east and west 25 miles. The area included is 319,232 acres, or about 499 square miles.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The first permanent settlement in the area now included within Henderson County was made between 1810 and 1815, near the spot where the town of Lexington, the county seat, now stands. The county was organized in 1821, and as laid out was a square whose dimension was 25 miles. It has since been modified in shape and made smaller by the formation of other counties.

At the time of the organization of the county the settlers were few and the means of transportation crude and slow, so that then, and for many years afterwards, the crops grown were mostly for home consumption and the exports from the county amounted to little. Prior to the civil war the inhabitants had to depend entirely on the soil for their support, except for the income from the sale of a few staves which were shipped by boat down the Tennessee and Mississippi rivers to New Orleans.

The larger number of the settlers came from North Carolina, though there were also many from Virginia, South Carolina, and Georgia. They usually built their cabins near some spring or stream and on the rolling upland instead of on the more fertile bottoms. There was never any "boom" in the county to cause rapid settlement of the country and the increase in the population was gradual, a few families moving in at a time.

Some of the land was reserved by the Government and disposed of by grants to the veterans of the war of 1812. Each of these grants called for 160 acres. If the settler wished more land it could be secured from the Government on the payment of a nominal price, which included the expense of surveying and recording, and many took advantage of this privilege.

The settlers in these early days secured the necessary supplies not produced at home from New York, Philadelphia, and Baltimore. The only means of transporting them was by wagon overland, and on account of the great distance and slowness of travel it took many weeks to make the trip.

The first soil to be cultivated was that on the uplands, and no attention was then given to the fertile lowlands along the stream bottoms. The first crops grown are still the principal crops of the county. The chief products were corn and cotton, with some wheat and oats, all of which were used for home consumption, except the cotton, which was then and still is the money crop. On account of the poor transportation facilities cotton was the only crop that could be shipped profitably. The only route was by way of the Tennessee and Mississippi rivers to New Orleans. Corn could be grown in much larger quantities than were needed for local use; consequently it was very cheap, at times selling as low as 75 cents a barrel.

In these early days many hogs were raised. They were fed and fattened on the mast of beechnuts, acorns, chestnuts, etc., the supply of which was very abundant and seldom failed. Cattle were raised, but only for home use, as there was no market for them. In recent years the production of cattle and mules has greatly increased.

Sorghum proved to be a successful crop as far back as 1858, but was not grown to any great extent until within the past twenty-five years. The lands were more productive prior to 1860 than at present and considerable clover was grown. Within the last fifteen years cowpeas have been introduced, so that now both clover and cowpeas occupy a prominent place in the crops planted. Wheat was formerly grown extensively, but small yields and poor quality have served greatly to decrease the acreage.

In 1858 Jackson and Huntington became railroad towns, and for many years much of the produce of the county, especially from the western part, was hauled to these two points for shipment. They are about 25 miles distant from Lexington. Perryville, 25 miles east of Lexington, was and still is the most accessible and important shipping point on the Tennessee River for the farmers of the county. In 1888 the Tennessee Midland Railroad, now a part of the Nashville, Chattanooga, and St. Louis Railway, was completed across Henderson County, extending westward to Memphis and eastward to the Tennessee River at Perryville. A few years later the road from Lexington to Hollow Rock Junction was built, making connections with the main line of the same system. With the building of these railroads shipping became less difficult and the timber, before almost worthless, became valuable and a source of considerable income to the land owners and to the county at large through the expenditure for labor in cutting and manufacturing it. A large part of the merchantable timber was removed within the ten to twelve years following the opening of the railroads, though staves and railroad ties are still cut and shipped at a profit.

The agricultural conditions were greatly influenced by the change induced by the civil war. Labor became difficult to secure, costly, and not very satisfactory, and the once fertile fields were left idle and subject to erosion, which transformed some of them into gullied hillsides worthless for agriculture. Apparently no effort was made to prevent this serious damage. In recent years more attention has been given to the bottom land, much of it having been cleared and put under cultivation, yielding fine crops. Land is still cheap, and on that account but little care is given it, for when one field is exhausted or seriously eroded another is cleared and cropped in the same way.

CLIMATE.

There is only one station of the Weather Bureau situated within Henderson County, that being at Wildersville, in the northern part of the county. Jackson, from which figures are given in the appended table, is in Madison County, 25 miles west of Lexington. The normals given in the table for Wildersville are deduced from records covering the past eight years. The highest temperature recorded in that time was 100° F., occurring twice the same year, July 12 and July 23, 1901; the lowest, −18° F., occurred February 13, 1899. The greatest precipitation for any one month occurred during June, 1900, being more than one-half inch a day or 15.85 inches for the month; the least, 0.30 inch, occurred during September, 1903.

The average length of the growing season, as shown by the same records, is 210 days, the average date of the last killing frost in spring being April 4, and of the first in fall November 1. The date of the latest killing frost in spring is April 17, 1905, and of the earliest in fall October 23, 1898, and on the same date in 1904, thus shortening the growing season only 21 days.

The following table shows the normals for both temperature and precipitation for each month and for the year:

Normal monthly and annual temperature and precipitation.

Month.	Wildersville.		Jackson.		Month.	Wildersville.		Jackson.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	*°F.*	*Inches.*		*°F.*	*Inches.*	*°F.*	*Inches.*
January	38.6	5.44	39.4	4.57	August	77.5	5.11	77.8	2.58
February	37.9	3.86	40.4	3.14	September	71.1	2.45	72.3	2.30
March	52.4	5.13	50.1	4.87	October	60.4	2.52	58.8	2.27
April	58.1	3.84	60.8	4.95	November	49.6	3.67	49.5	4.16
May	69.0	4.86	68.8	3.82	December	40.0	5.29	41.6	5.01
June	74.6	5.19	76.9	4.44					
July	77.8	4.12	79.0	4.59	Year	58.9	51.48	59.6	46.70

PHYSIOGRAPHY AND GEOLOGY.

Henderson County lies in both the Mississippi and Tennessee river basins. The watershed between these two river systems passes in a northerly and southerly direction through the western part of the county, dividing it so that the larger part is in the Tennessee basin.

Being the highest part of the State between the two rivers, the topography of a large part of the county is extremely rough and broken. There are two very distinct topographic features—the stream bottoms and the rolling, broken uplands. The bottoms are found in more or less narrow strips along most of the streams, their width usually depending upon the size of the stream. The smaller streams of the county are only slightly higher than the river and have shallow, tortuous channels. The low, level bottoms lying along them are therefore often overflowed. In extent these lands form only a small part of the county, but agriculturally they are of extreme importance. The largest areas of bottom land are found along Beech River, the two branches of Forked Deer River, Big, Browns, Sulphur Fork, and Hurricane creeks, and several other smaller streams.

The uplands occur in all parts of the county and vary in topography from moderately rolling to rough and hilly, the hills usually forming irregular ridges. The roughest parts of the county are east of Wildersville, the northwestern part of the county, and in the vicinity of Shadyhill and Reagan. These rough, hilly sections are mostly wooded with white, red, black-jack, and post oak, with a few chestnut, hickory, and other miscellaneous hardwoods. In a section of the eastern part of the county beech is also found on the uplands. Numerous erosions occur in all parts of the uplands, some of them being 30 to 40 feet in depth, exposing the substratum of varicolored sands. The moderately rolling portions have been cleared and are quite extensively cultivated.

The elevation of the county varies from about 400 to about 750 feet above sea level. The highest point, 547 feet, for which reliable data could be secured, is at Timberlake; the lowest, 393 feet, at Luray and 394 feet at Chesterfield. The maximum and minimum figures will depart somewhat from those given, which are railroad elevations, the greatest variation being in the direction of the maximum.

As before stated, the county lies in both the Tennessee and Mississippi basins. The watershed enters the county on the north about 6 miles west of Wildersville and passes in an irregular line southward, crossing the railroad near Life. The main streams draining that part of the county lying in the Mississippi basin are the two branches of Forked Deer River and their tributaries. The Tennessee basin slope has two general drainage systems besides several smaller ones. In the northern part is the Big Sandy River and its tributaries, which flow northward into Carroll County and thence into the Tennessee near the north State line. The principal stream of the county is Beech River. It rises west of Timberlake and flows in a southerly course until in the vicinity of Hinson Springs, when it turns eastward and flows in that direction into and through Decatur County and empties into the Tennessee about 12 miles to the east of Darden. It has many branches, the largest being Big Creek, which flows into it just over the line in Decatur County, Browns Creek from the north, and Flat, Cane, and Piney creeks and a few others from the south. The county is generally well drained, except for some of the low, level bottoms.

The rocks underlying the county and entering into the formation of its soils consist of the unconsolidated sands and clays of the greensand or shellbed formation of the Cretaceous and the Orange sand formation of the Lafayette group of Tertiary age.

The whole of the eastern part of the county and the extreme southern part are formed by the outcrop of the greensand. This formation owes its color to a relatively small admixture of a greenish mineral called glauconite. It also contains numerous fossil shells and often small particles of mica. Very often on or near the surface of this formation there are iron concretions, some of them of considerable size and probably averaging the size of a man's head. Overlying these Cretaceous deposits and extending over the larger part of the county is the Orange sand formation of the Lafayette division of the Tertiary. The Orange sand consists of stratified and cross-bedded sands of orange, red, yellow, brown, and white color, with sometimes an interstratified bed of white, gray, or variegated clay. Iron concretions, pipes, and ferruginous sandstone occur promiscuously throughout these sands. In the western part of the county there are several irregular-shaped areas of a partially consolidated pearl-gray clay underneath the surface materials.

The surface material, loess, which is more important in its bearing on the soils, belongs to an entirely different geological period and comes from a far different source. Safford, in his Geology of Tennessee, in speaking of this formation, designates it as the "bluff loam," and states that "its eastern edge is with difficulty defined," and his maps give an arbitrary boundary for its eastern limit which is far to the west of the area surveyed. However, this "bluff loam," which is from 40 to 100 feet in thickness at the bluff along the Mississippi River bottoms, its western limit, extends eastward, covering Henderson and the surrounding counties, and it is believed extends to the Paleozoic rocks on the east. This loess, a mixture of fine sand, silt, and clay, gradually thins out to the eastward, so that over this county it will not average more than 3 feet in thickness. It is supposed to be derived from glacial material which has been borne southward by glacial floods, deposited in shallow water, and redistributed by the wind. It is through the weathering of this loess, with certain modifications due to the underlying material, that the upland soils of the county have been derived.

The bottoms consist of the wash from the uplands and sediments deposited by stream overflow and belong to the most recent geological age.

SOILS.

Four types of soil are described in subsequent pages of this report, the materials classed as one type covering over 75 per cent of the total area of the county. About another 15 per cent is occupied by a very valuable bottom land type.

The following table gives the names and areas of the several types, while the accompanying map shows their distribution:

Areas of different soils.

Soil.	Acres.	Per cent.
Lexington silt loam	241,344	75.5
Waverly loam	47,360	14.9
Safford silt loam	28,544	8.9
Norfolk sandy loam	1,984	.7
Total	319,232	....

LEXINGTON SILT LOAM.

The Lexington silt loam, to a depth of about 12 inches, is a gray or yellowish-gray mellow silt loam. In the virgin state the surface 2 or 3 inches is usually slightly darker in color than the rest of the profile, owing to the accumulation of a small amount of organic matter. Where the type is under cultivation it is also usually somewhat darker in color and more friable. The subsoil to a depth of 36 inches consists either of a compact, plastic silt loam, slightly heavier than the soil, or of a silty clay varying from yellow to brown in color or sometimes tinged with red. Very often the subsoil in the lower depths is mottled yellow, brown, and gray and has a mealy texture. At an average depth of 3 feet the Orange sand occurs. The upper portion of this formation is usually a reddish medium sand with just enough clay to act as cementing material. Sometimes it occurs nearer the surface than 3 feet and very often erosion has exposed it on the surface or mixed the materials with the silty soil covering, making a sandy phase of the type. Such areas are so small or occur so irregularly scattered throughout the whole type that they could not be shown on the map with any degree of accuracy. In other places the silty covering is considerably more than 3 feet deep, and over these areas neither the soil nor subsoil is modified by the underlying sands. These areas are very much like the Memphis silt loam, and had they been larger would have been correlated with that type. As before stated, this type is the most extensive in the county and is found in all parts of the county, intersected by the narrow bottom lands and either surrounding or almost surrounding all the other soils.

The topography of the Lexington silt loam is moderately rolling to hilly. The hilly portion consists mainly of long, winding ridges, forming the watersheds between the streams, and is sparsely settled and but little cultivated. The more level portions, occurring largely in the central part of the county, are more thickly settled and here is found the best farm land and greatest development of the type. Much of the rough topography is due to erosion. Almost every rain washes little gullies in the plowed lands, and when once started they quickly extend and form deep erosions. Some of these have reached a depth of 30 or 40 feet. Many of the old abandoned fields are seriously cut up by these gullies, and scarcely any effort has been or is being made to prevent their formation and extension. The rolling lands should be given contour cultivation or be terraced to prevent this damage.

The topography gives practically all of the type excellent drainage. The character of the deep subsoil is such that considerable of the soil moisture is removed by seepage. The growing crops are seriously injured by droughts if of extended duration, but they are seldom damaged by wet weather, as are those on the lowlands. Springs are more numerous than in any other soil, and the well-water is of very much better quality than that occurring in the greensand formation.

Both the soil and the subsoil of the typical Lexington silt loam have a common origin, but when we consider its sandy phases we must look to two far separated and widely different sources for the materials forming them. At one time the region now occupied by Henderson County, as well as nearly all of west Tennessee, was submerged in a shallow sea. At this time the stratified, cross-bedded, and many-colored Orange sand, which underlies the type and contributes to its modifications, was laid down. The whole region was subsequently elevated and erosive agencies carved it into hills and valleys. During the Glacial Period it is believed that the present surface material was brought from the ice fields farther north by glacial flood waters deposited in shallow water and distributed by the wind.

The Lexington silt loam is adapted to the general farm crops of the section. Corn yields year after year from 15 to 20 bushels per acre, with an occasional crop on the best land of 30 to 40 bushels. Cotton is quite extensively grown and yields on an average from one-fifth to two-fifths of a bale per acre. Much of the less rolling land will yield from one-half to two-thirds bale of cotton and from 25 to 35 bushels of corn, but on the contrary much of it will not come up to the average given even in favorable seasons. Clover grows readily, except for difficulty in securing a stand in dry seasons, and should be grown more extensively. Cowpeas are grown by almost every farmer, very often being planted in the corn at the time of the last cultivation. The practice of planting this crop, as well as other legumes, is to be commended, as it leaves the land in better condition, besides furnishing valuable forage. A prominent farmer says: "I can grow a crop of corn on the same field year after year, and by planting cowpeas with it each year secure a larger yield each succeeding crop and leave the land in a more productive state than when I began." Strawberries do well, but have not been extensively grown. All kinds of vegetables are easily grown, and if shipping conditions were better would be the source of a considerable income to the farmers. The grazing land of this type could be made to return greater profits than at present, as Japan clover and other grasses grow luxuriantly without seeding and are capable of furnishing feed for a much greater number of cattle than are now kept.

The natural forest growth consists of white, red, post, and black-jack oaks, chestnut, some hickory, and black gum. Most of the merchantable timber has been removed, yet many railroad ties and staves are still made.

The value of the Lexington silt loam varies with the topography. The rough ridge land can be bought for $2 to $5 an acre, some of the more moderately rolling for $5 to $7, and the best and more level areas for from $15 to $20 an acre.

The following table gives the average results of mechanical analyses of typical samples of the Lexington silt loam:

Mechanical analyses of Lexington silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
12799, 13502	Soil	0.3	1.9	2.0	5.7	5.2	69.4	15.2
12800, 13503	Subsoil	Tr.	1.3	1.5	4.3	1.6	63.0	27.9

To ascertain its manurial requirements an examination of this soil was made by the wire-basket method. For this purpose a sample was selected from a field which had recently received a rather heavy application of stable manure, but prior to that time had been in constant cultivation for many years without the use of fertilizers of any kind.

The results obtained indicate that an excellent increase in productiveness may be secured by the use of stable manure; that nitrate of soda will give a good increase, while a small increase may be obtained by the use of cowpeas and lime. Lime alone, acid-phosphate, or sulphate-of-patash tests showed little or no improvement in the soil.

These tests were made with wheat plants as an indicator. To what extent they are applicable to other and unrelated crops or to fields which have previously received different treatments has not been determined, but they are no doubt applicable in a general way to a large part of this soil throughout the area.

SAFFORD SILT LOAM.

The soil of the Safford silt loam, to a depth of 8 to 10 inches, consists of a gray or light-yellow silt loam. It is loose and rather incoherent when dry and is easily cultivated, a good tilth being secured. When wet, it packs slightly. The surface material grades into a tough plastic clay or clay loam having a red or reddish-brown color, and this, at a depth of about 3 feet, grades into greensand. Sometimes the greensand, or a grayish yellow clay derived from it, is nearer the surface, and quite often the soil has been entirely removed by erosion, leaving the heavier subsoil exposed. In other places the soil is deeper than in the typical profile, but both these phases are of local occurrence. The boundaries of this type are not distinct, as it passes gradually into other types.

The Safford silt loam occurs only in the eastern and southern parts of the county, reaching its greatest development in the vicinity of Sardis. The topography does not favor extensive cultivation. It is rolling to hilly and erodes badly. Very little of it is gently rolling, and even where it has been cleared and cultivated scarcely any care has been given it, as is evident from the many abandoned fields, which, if proper steps had been taken to prevent erosion, would still be producing good crops. Terracing or contour cultivation should be practiced on these rolling lands.

While the Safford silt loam has excellent natural drainage, the heavy character of the subsoil prevents the loss of soil moisture by seepage, and crops do not suffer from drought as quickly as on the other upland soils of the area.

The origin of this soil is due to two widely different agencies. The silt loam soil covering is undoubtedly due to a deposit of loess derived from glacial material farther northward, while the subsoil is derived from the weathering of the greensand marl or a shallow deposit of clayey material above it or from a mixture of both. The greensand owes its color to soft greenish grains of a mineral called glauconite, a compound of silica, oxide of iron, alumina, potash, and water. In deposits where the proportion of this mineral in the deposit is high the marl may have some value as a fertilizer, as, for instance, in some parts of New Jersey. An analysis of an average sample of the greensand, as it occurs in Henderson County, shows only 0.1 per cent of phosphoric acid—an insufficient amount to warrant its use. In many places throughout the soil type iron concretions are present in great quantities, some of them being as large as a bushel measure and the average being about the size of a man's head.

The Safford silt loam is adapted to all of the general farm crops grown in this latitude, such as corn, wheat, cotton, hay, etc. The heavy subsoil makes it more desirable for clover and wheat than any of the other upland soils. Formerly considerable wheat was grown, yielding from 15 to 20 bushels per acre, but in recent years the yield has decreased to 6 or 8 bushels, and often less, and the acreage is now very small. Corn will produce an average of from 15 to 25 bushels and cotton from one-third to one-half bale per acre, and in favorable seasons these yields may be exceeded materially. A rotation of crops and the growing of leguminous crops, with the occasional plowing under of the latter, would aid greatly not only in the maintenance of the productivity, but also in the reclamation of the abandoned fields. Much of this soil is used for grazing and makes an excellent pasture, Japan clover growing luxuriantly.

The native timber growth consists of white, red, black-jack, and post-oak, chestnut, some hickory, and beech. One of the distinguishing features of the type is the beech, as it is not usually found on any of the other upland soils. Most of the merchantable timber has been removed.

The following table shows the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Safford silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
13238, 13504, 13506	Soil	0.1	0.7	0.8	3.8	16.9	60.7	16.5
13239, 13505, 13507	Subsoil	.1	.3	.3	2.8	12.7	29.9	53.4

NORFOLK SANDY LOAM.

The Norfolk sandy loam is quite variable in character. An average section to a depth of about 9 inches shows a gray or brown light sandy loam, the sand being mainly of the fine and medium grades. The subsoil consists of a slightly heavier sandy loam, having a yellow or yellowish-red color. In depressions the soil is much deeper and may be either more loamy or more sandy than the average. On the small elevations the subsoil itself is often exposed and occasionally consists of a bed of loose yellowish sand.

Two of the areas of this soil differ from the rest of the type in that they carry a considerable quantity of large and small fragments of a reddish-brown ferruginous sandstone. One of these stony areas is covered by a stunted growth of shortleaf pine, the only forest of this species in the county.

The Norfolk sandy loam occupies only a very limited area in the county, the largest bodies of it being situated west of Wildersville and near the mouth of Piney Creek. There are two other small bodies of it—one about 4 miles northwest of Lexington, the other about the same distance north of Chesterfield. Many small irregular-shaped areas of this sandy loam occur in the Lexington silt loam, which could not be shown on the soil map with any degree of accuracy and were therefore included with that soil.

The topography of the Norfolk sandy loam is one of its distinguishing features. It occurs in the rolling country of the uplands and has a billowy appearance, a depression here and an elevation there, arranged in no regular order. The slight elevations all have about the same general level. The topography of the stony phase differs from the remainder in that it does not have the billowy appearance and is quite hilly. Owing to its topographic position and open texture the drainage is excessive.

The Norfolk sandy loam has been derived from the sandy clays of the Lafayette in areas where the loess covering has been removed by erosion or in some cases by the admixture of wind-blown sand with the materials of the loess.

This type is the least productive soil of the county. The depressions generally produce fairly well, but the elevations are almost sterile. The soil is best adapted to early truck and other crops which need a well-drained warm soil. The growing and turning under of leguminous crops, such as clover and cowpeas, and the liberal application of barnyard manure, would not only cause better yields through the addition of organic matter and nitrogen, but also through increasing the power of the soil to retain moisture.

Corn and cotton are the crops grown most extensively, and small yields are obtained, the average yield of the former being not more than 8 to 10 bushels, and of the latter not more than one-sixth to one-fifth bale per acre. A few peach trees are seen, and usually they produce well. The hilly stony phase is adapted to peaches and small fruits, but is not at present cultivated to any great extent.

The following table gives the average results of mechanical analyses of typical samples of the Norfolk sandy loam:

Mechanical analyses of Norfolk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
13018, 13496	Soil	0.1	5.8	14.8	31.0	5.5	32.4	10.1
13019, 13497	Subsoil	.1	4.1	10.7	22.7	4.4	36.6	21.0

WAVERLY LOAM.

The surface soil of the Waverly loam, to a depth of 10 to 12 inches, consists of a fine mellow brown loam. The soil is underlain by a subsoil of gray, grayish-yellow, or mottled gray and brown loam, having about the same texture as the soil. In the eastern part of the county both soil and subsoil contain fine particles of mica. In some places it approaches a fine sandy loam in texture, and along some of the larger streams it grades toward a rather heavy silty clay. Near the sources of the streams and in places along their courses the areas are inclined to be rather wet and like the Meadow mapped in other areas. A similar condition occurs in some of the lower parts of the wider bottoms.

The Waverly loam, which is strictly a bottom land type, occurs along the streams in all parts of the county, the most extensive and important areas being along Beech River and its larger tributaries in the eastern part of the county and along the North and South Forked Deer rivers in the western part. The surface is nearly level and but little above the streams, and the natural drainage is inclined to be rather poor. In some few instances the straightening of the stream courses and the making of open ditches has helped to remedy this condition. The extension of this practice is strongly recommended, for in this way practically all of the low, wet areas of the type can be brought under cultivation and the value of the whole type enhanced. These bottoms are often overflowed, but the crops are seldom destroyed.

The Waverly loam is an alluvial soil formed of the materials washed down from higher levels. This process of formation is still going on, as every rain washes down material from the hillsides and every overflow adds a deposit of sediments. In recent years low, swampy places in some of the bottoms have been filled in, making firm land. The process of the formation of the Waverly loam has not progressed as far in the wider bottoms as it has along the smaller streams. In many parts of the wide area along Beech River and in the areas along the North and the South Forked Deer rivers there exists the heavier silty clay phase of the type and a few low wet places which have not yet been built up by the deposition of the more loamy materials.

This is the most productive soil in the county and is adapted to the general farm crops of the region. Corn is probably most extensively grown and yields from 15 to 50 bushels per acre, the average being about 25 bushels. Cotton does relatively well, averaging one-half bale per acre, and in favorable seasons a yield of 1 bale is not uncommon. A few peanuts are grown in the eastern part of the county. They will probably yield from 40 to 50 bushels per acre. Cowpeas are quite extensively planted and yield about 1½ tons if cut for forage, or about 30 bushels of seed per acre.

The native timber growth consists of black and sweet gums, a few tupelo gums, beech, oak, hickory, etc. Much of the timber has been removed, yet considerable of it has not been cut over at all. The best part of the Waverly loam is the most valuable farm land in the county. The average price is about $20 an acre; but choice improved tracts of it are valued much higher. Unimproved it sells for $10 to $12 an acre.

The following table shows the average results of mechanical analyses of typical samples of the soil and subsoil of the Waverly loam:

Mechanical analyses of Waverly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
13020, 13494	Soil	0.3	0.5	0.4	8.1	15.4	58.5	16.6
13021, 13495	Subsoil	.1	1.1	.7	11.0	18.0	44.8	23.6

AGRICULTURAL CONDITIONS.

The general condition of the farming classes of Henderson County is good, though the opportunities for development have by no means been exhausted. The farm dwellings are often old-fashioned and usually built of logs. In recent years, however, in the parts of the county having the more productive soils, the buildings erected have been more modern, indicating the general progress. As there are few crops grown that require storage, the outbuildings are few and small. The welfare of the laboring classes is increased by the opportunities for work afforded in lumbering. Credit is good, the banks do a thriving business, and a commercial failure is an uncommon occurrence. There is rural free delivery of mail to nearly all parts of the county. The community is fairly well supplied with schools, and all together the prospects are for continued general advancement.

A little more than 50 per cent of the farms are operated by the owners. Of the remainder practically none are rented for cash. Under the share system, where the owner furnishes tools and stock to do the work, he usually receives one-half the produce; but where the tenant furnishes everything he gives as rent from one-fourth to one-third of the crops. When land is rented, cotton is almost always the crop grown.

About 90 per cent of the whole county is classed as farm land, which is apportioned among 3,008 farms of an average size of 99.4 acres. Of the land classed as farm land a little more than 36 per cent is classed as improved, and of this only 68 per cent is under cultivation. "Improved" land as applied to this section is not comparable to the same term as used to describe the land of a more thickly settled and more highly developed part of the country. If it were, the percentages given would be very much smaller.

The labor is drawn from both the colored and the white races and is not as easily secured nor as efficient as could be desired. The negroes prefer to live in the towns and work on public work rather than in the rural sections. Wages are low and not much farm help is needed. The price paid for the best hands is $1 a day and very often 50 cents is all that is offered for the average laborer. Most of the help is hired by the day instead of by the month, as the farmers need assistance only at certain seasons. In 1899 the average amount paid out for labor on each farm was between $6 and $7.

The two principal crops of the county are corn and cotton. Cotton is the money crop, and nearly every farmer has his cotton fields. The crop of 1899 amounted to nearly 5,000 bales, a yield of a little less than one-third bale per acre for the total area planted. The corn crop for the same year was between 750,000 and 1,000,000 bushels, a yield of a little over 20 bushels per acre on the acreage planted. Practically all of the corn grown is consumed at home. The total acreage of wheat was about one-seventh that of corn, and the average yield per acre was between 4 and 5 bushels. The acreage of wheat is constantly declining, owing mainly to the small yields secured.

Oats, cowpeas, and the grass crops come next in importance, but the acreage devoted to them is comparatively small.

But few tools of improved pattern are used in planting, cultivating, and harvesting the crops. Improved methods should be introduced, especially in the care of the rolling lands. At present they are allowed to wash with each rain and when too badly eroded are abandoned for new fields. The damage due to this cause should be prevented or at least held in check by contour cultivation and terracing. A rotation of crops, which should include leguminous crops, should be introduced. Fertilizers are not used to any extent, nor is much thought given to husbanding and using the stable manure.

The farm animals are no small item in the wealth of the county. Many fine mules are raised for market, and every farmer has a large number of hogs. Poultry products are also a source of considerable income. A large number of beef cattle are raised, and the number could be safely increased, as there are thousands of acres of grazing land lying practically idle. A few goats and more sheep are among the live stock kept in the county.

Transportation facilities are not as ample nor as efficient as could be desired. The Paducah and Memphis Division of the Nashville, Chattanooga, and St. Louis Railway crosses the county in a northerly and westerly direction from Lexington, and the Perryville Branch of the same system extends eastward from Lexington. With no competing lines freight and express rates are high. In fact, the freight rates from St. Louis and Paducah to Perryville by steamboat are said to be less than the freight rate for the short haul of 12 miles by rail from Perryville to Darden. Some of the shipping is still made by water from points on the Tennessee River. With lower freight rates and a faster service the introduction of truck growing would, it is thought, prove profitable.

The county roads are very numerous and exceedingly poorly kept. No good roads exist in the county, and during some seasons of the year they are practically impassable, except on horseback.

The population of the county is about 18,000, of which about one-ninth is colored. The largest town and county seat is Lexington, with a population of about 1,500. There are several small towns, Wildersville, Scotts Hill, Sardis, Darden, and Luray being the largest and most important. The home market is very limited, and the supplies largely exceed the demand. Memphis and Jackson on the west, Nashville, with connections for the north and east, and Paducah, with connections for the large cities of the north, are the best outlets for the products of the county.

SOIL SURVEY OF MADISON COUNTY, KENTUCKY.

By **A. M. GRIFFEN** and **ORLA L. AYRS**.

LOCATION AND BOUNDARIES OF THE AREA.

Madison County is situated in the east-central part of the State of Kentucky and is included approximately between parallels 37° 30′ and 37° 55′ north latitude and meridians 84° 04′ and 84° 30′ west longitude. It comprises an area of 279,808 acres, or about 437 square miles. It forms the southeast corner of that part of Kentucky known as the "bluegrass section," though this term can not be applied to all portions of the county. The Kentucky River in its winding course forms the county boundary on the northeast, north, and northwest, and separates Madison County from Clark, Fayette, and Jessamine counties. The county is bounded on the east by Estill County, on the south by Jackson and Rockcastle counties, and on the west by Garrard County. Richmond, the county seat and largest town, is located nearly in the center of the county. Berea, in the southern part, is also a town of considerable importance.

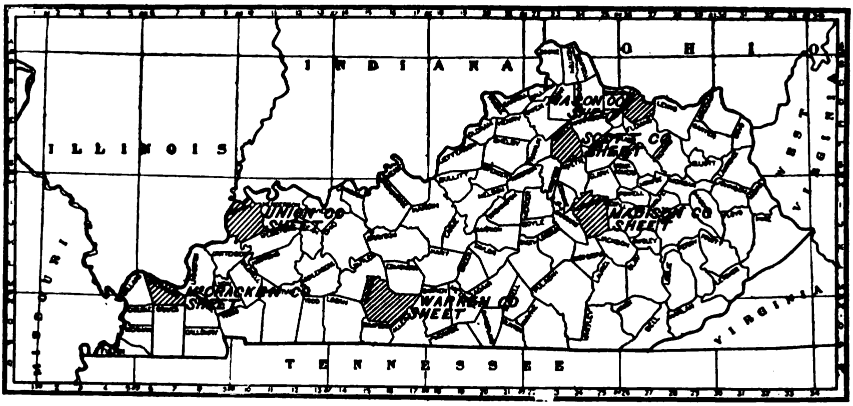

FIG. 27.—Sketch map showing location of the Madison County area, Kentucky.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The first permanent settlement in the region now included within the limits of Madison County was made in the spring of 1775, as the result of an expedition from Rutherford County, N. C., led by Daniel

Boone. A point upon the Kentucky River was selected for the site of the frontier town, called Boonesboro, and small forts were built here and at Fort Estill and several other points for protection against the hostile Indians. Immigration from North Carolina and Virginia increased rapidly after the close of the Revolutionary war. The productive and easily tilled soils of the region were in striking contrast with the rough country from which many of the settlers came, and the natural advantages thus offered for agricultural pursuits account for the settlement and early growth of the county. Soon after Kentucky was admitted into the Union as a State Madison County was reduced to its present size and the county seat changed from Milford to Richmond. The population of the county, in common with that of a large part of the State, is mostly native born.

Madison was one of the border counties during the civil war and suffered considerably from guerrilla warfare.

The early farm products of the county consisted of corn, wheat, and tobacco, and were floated down the Kentucky, Ohio, and Mississippi rivers and marketed in New Orleans. Wheat does not hold the place it once did in the list of products. Except during the early period of settlement, stock raising has been and is now the leading industry on the farms of the county.

CLIMATE.

The climatic conditions in Madison County are similar to those prevailing over the greater part of central Kentucky. There are no extreme temperatures in winter or summer. In the following table the normal monthly temperature and precipitation are given for as many months of the year as are available from the records kept at Richmond, while complete figures for the year are given from the Weather Bureau station at Lexington, situated in an adjoining county. Though usually sufficient for crop purposes, the rainfall varies considerably from year to year. At Richmond the average date of the last killing frost in spring is April 12 and of the first in fall October 16.

Normal monthly and annual temperature and precipitation.

Month.	Lexington.		Richmond.		Month.	Lexington.		Richmond.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	*°F.*	*Inches.*		*°F.*	*Inches.*	*°F.*	*Inches.*
January	33.1	4.82	....	....	August	74.0	3.52	75.5	2.94
February	36.2	3.70	....	....	September	68.9	2.54	70.7	2.30
March	42.6	4.90	....	....	October	55.8	2.22	58.0	2.33
April	55.9	3.72	55.2	3.40	November	44.5	3.72	46.0	2.78
May	63.0	3.49	65.4	3.38	December	38.6	3.40	34.4	2.70
June	73.6	4.25	73.6	3.62	Year	55.1	45.38	....	....
July	75.4	5.10	77.1	3.64					

PHYSIOGRAPHY AND GEOLOGY.

Madison County lies largely in that part of the State known to geologists as the Lexington peneplain. In the area surveyed the general elevation of this plain above sea level is from 800 to 900 feet, only a few points reaching an elevation of 1,000 feet. The Kentucky River makes a semicircuit of the county on its northern side and flows through a narrow, deeply eroded valley whose sides are prominent bluffs and precipitous cliffs from 200 to 300 feet high. All the main creeks of the county flow in a northward direction and empty into this river, whose level is about 550 feet above sea level. Starting from the comparatively high elevation of 900 feet the streams have a rapid descent until the river level is reached, and in their progress have carved out deep, narrow valleys, their side tributaries making deep indentations into the long ridges. These streams are all actively engaged in deepening their channels, which accounts for the absence of extensive bottom lands along their courses. In the central part of the county and about the stream heads the topography is gently rolling, and in the eastern part there are some quite extensive level areas.

A less extensive physiographic division consists of a series of rough and broken hills, locally called mountains, rising about 500 feet above the plain in the southern and southeastern parts of the county. These are probably the remains of a former higher plain which has been so cut and eroded as to form the sharp peaks and narrow ridges now characteristic of this section of the county.

Geologically,[a] the area surveyed presents some very interesting features. A large number of members of the Paleozoic age are found exposed, extending from the Lower Silurian period to the Carboniferous. In nearly every case each formation is represented by a distinct type of soil. The rocks are all stratified deposits laid down in an ancient ocean, and are inclined slightly to the southeast, which is accounted for by their position upon the southern slope of the great Cincinnati anticline. The lowest members, in the western part of the county, consist largely of limestones, showing that they were deposited in a comparatively deep and quiet water. The later deposits of shales indicate a shallower and more sediment-laden condition of the sea.

The principal soil-forming rocks in the western and central parts of the county are a fine-grained calcareous sandstone, known as the Garrard sandstone, and the Richmond limestone formation, from which are derived the Dekalb loam and the Hagerstown series of soils, respectively. These formations are part of the group now classified as Cincinnatian. In the eastern part of the county the Richmond limestone passes into a series of greenish shales, probably corresponding to the Clinton or Niagara, and named Panola by the U. S. Geological Survey. Over this is found an Upper Silurian limestone, which weathers to a rusty brown. The Devonian era is represented by a series of black shales, which give rise to the Dekalb silt loam. The principal mountain formation is the Waverly, a subcarboniferous shale, overlying which there is usually a capping of Newman limestone, as well as some sandstone and conglomerate. A few of the tops of the high, isolated hills or mountains are covered by coal-bearing shales.

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[a] The discussion of the geology of Madison County is based principally upon information obtained from the Richmond folio of the U. S. Geological Survey.

The predominating surface formations in the eastern part of the county are but a few feet in thickness, a feature which is responsible for a change of soil type with any considerable change in topography. In the extreme eastern part there are limited deposits of clays and fine sands classed as of Neocene age. Sink holes are sometimes found in the Richmond formation, but these are not numerous.

The rocks of the area are utilized to a considerable extent as road material, and certain kinds are used in constructing stone fences and foundations for buildings. Brick kilns are established at several points, and an excellent pottery clay is worked to a limited extent in the vicinity of Waco.

SOILS.

Owing to the diversified character of the geological formations outcropping within the area, 13 different types of soil were found in Madison County. Over one-half the entire area is occupied by limestone soils, while those derived from shales are next in importance. The following table shows the actual and relative extent of each type:

Areas of different soils.

Soil.	Acres.	Per cent.
Hagerstown loam	107,072	38.3
Hagerstown clay	43,392	15.5
Hagerstown stony clay	33,792	12.1
Dekalb silt loam	31,424	11.2
Dekalb loam	20,800	7.4
Dekalb shale loam	18,880	6.8
Wabash silt loam	12,672	4.6
Guthrie clay	4,480	1.6
Cumberland loam	4,288	1.5
Rough stony land	1,728	.6
Dekalb fine sandy loam	832	.3
Muck	320	.1
Riverwash	128	.0
Total	279,808	

HAGERSTOWN LOAM.

The Hagerstown loam is the most extensive, as well as the most valuable, type of soil in the county. It is locally known as "bluegrass land." The soil is a brown or dark-brown very heavy loam, silty loam, or clay loam from 8 to 18 inches deep, with an average depth of about 12 inches, becoming lighter in color with depth and grading into a heavy, dark-yellow clay subsoil, which in turn usually rests upon solid limestone rock 5 or 6 feet below the surface. Occasionally the subsoil has a reddish or reddish-brown tinge, but its usual color is yellow. In some localities the soil is of a yellow or light-yellow color, with a gray surface, and in many places it contains small iron concretions and nodules of cherty material. As a rule, this type contains very little or no rock débris. The main difference between it and the typical Hagerstown clay is in the greater depth of the brown loamy top soil and the greater depth to bed rock.

The Hagerstown loam is found principally in the western and central parts of the county, extending north and south in a wide and rather irregular belt, broken by areas of the Hagerstown clay, which borders the stream courses. The topography of the type is gently undulating or rolling, which insures almost perfect natural drainage.

It is a residual soil and owes its origin to the disintegration, in place, of bedded limestone. The western edge of the belt of this type is coincident with the running out of the limestone, its place as a surface formation being taken by the Garrard sandstone. In some areas the soil is derived from the upper shaly members of the Richmond formation, and instances were observed where the soil was formed from the limestone, but was influenced to a certain extent by small disintegrated portions of the shale, which were left as a result of incomplete erosion.

The Hagerstown loam for the most part was originally covered with a growth of hickory, oak, black walnut, locust, and maple, with a papaw and wild-cane undergrowth. It was one of the first types of soil in the county to be used for farming purposes, and now practically all of it is under cultivation. Upon this type are to be seen a number of those old colonial mansions which are found scattered over much of the bluegrass region of Kentucky.

The Hagerstown loam is well suited to a variety of crops, including corn, wheat, clover, oats, rye, hemp, tobacco, millet, hay, and bluegrass. Its adaptability to corn, forage crops, and pastures has tended to make stock raising the most important farm industry. The luxuriant pastures seen upon this type surpass those of some of the bluegrass counties farther north, since as a rule the soil is deeper and better able to withstand drought. The leading crops grown at present are corn, wheat, hay, and tobacco. Corn produces from 25 to 70 bushels per acre, averaging about 50 bushels; wheat from 12 to 16 bushels; tobacco 1,000 pounds, and hay from 1 to 1¾ tons per acre. The yield of wheat, as well as the acreage in this crop, has decreased during the last few years, while tobacco and hemp are being more extensively grown.

The market value of the Hagerstown loam has increased rapidly within a few years, the price now ranging from $50 to $130 an acre, according to location and improvements.

The following table gives the average results of mechanical analyses of samples of this soil:

Mechanical analyses of Hagerstown loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13265, 13580, 13784, 13786, 13794.	Soil.........	1.5	2.9	1.2	1.8	3.4	61.0	27.9
13266, 13581, 13785, 13787, 13795.	Subsoil.....	1.5	3.0	1.3	1.6	2.4	57.1	32.8

HAGERSTOWN CLAY.

The Hagerstown clay to a depth of 3 or 4 inches usually consists of a dark-brown or yellowish clay loam or clay, grading into a very heavy dark-yellow clay subsoil. As a rule solid limestone rock is encountered 25 or 30 inches below the surface. Sometimes there is practically little or no difference in texture between soil and subsoil, both being a heavy clay. Some rock fragments and occasional outcrops of the bed rock are found in nearly all of such areas.

The type as mapped covers a wide range of soil conditions. The weathering of thin beds of massive limestone, in connection with the shales which directly underlie it, has formed a phase of the Hagerstown clay which in a single field often varies widely. In one place this may be a stiff, tenacious yellow or tan-colored clay 3 feet deep, in another place a light-yellow clay a few inches deep, underlain by lighter shaly material, while in other small spots it may be a greenish or drab heavy "soapstone" clay mingled with pieces of shale. This phase also occurs to a considerable extent in and coincides with a part of the badly washed and eroded sections in the northeastern part of the county.

The Hagerstown clay is found in all parts of the county, except the southern end. The clay areas are not broad, as a rule, but they are very numerous and border many stream courses. Through the central part of the county the soil is usually typical. With the deepening of the valleys toward the river and larger creeks which border the county there is a corresponding thinning of the soil covering their sides and an increased exposure of rocky material.

The Hagerstown clay is naturally well drained. Over much of the type, owing to its rough and steep topography, drainage is so rapid and excessive that serious damage from erosion has resulted.

The formation of this soil is due to the weathering in place of thin-bedded limestone, most of which belongs to the Richmond formation. There is a great contrast in the agricultural value of different parts of the type. Some areas, especially about the stream heads, compare favorably with the Hagerstown loam in productiveness, but the type as a whole is not so desirable. It is more difficult to work, and being a comparatively shallow soil it lacks the power to conserve a large quantity of moisture. There is also a tendency during a dry season to bake and become hard. Where not too badly eroded, the type is devoted to corn, tobacco, and pasture. In the western part of the county corn grown on this soil produces from 30 to 45 bushels per acre, and tobacco about 1,000 pounds per acre. Many of the clay hillsides, lying below the Dekalb loam, have received a certain amount of material washed from that type, making them especially suitable for the growing of Burley tobacco.

The following table gives the average results of mechanical analyses of the fine earth of Hagerstown clay:

Mechanical analyses of Hagerstown clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13259, 13782.......	Soil.........	1.0	3.3	1.4	1.9	2.2	46.9	42.9
13260, 13783.......	Subsoil.....	.3	2.9	1.3	1.9	2.1	39.4	51.8

HAGERSTOWN STONY CLAY.

The Hagerstown stony clay, in both soil and subsoil, is very similar to the Hagerstown clay. It is distinguished from the latter type by the quantity of stones or rock fragments it carries and by its rougher topography. The stones for the most part consist of flat slabs of thin-bedded limestone, with a few ledge outcrops. Although interfering seriously with cultivation, they are not so numerous as to preclude agriculture entirely except in a few cases. The greater part of the type occurs in the western portion of the county, while many small areas are found in the northern and eastern sections along the streams. Like the Hagerstown clay, the soil owes its origin to the weathering in place of thin-bedded limestone. Because of its topography it is a well-drained soil, and is often badly eroded. Where cultivated, the principal crops are corn and tobacco, and the yields are usually good.

WABASH SILT LOAM.

The Wabash silt loam is the only bottom-land soil in the area, and is of relatively small extent. The soil to a depth of 12 or 15 inches usually consists of a very heavy, dark-brown or nearly black silty loam or clay loam. The subsoil is a brown or slightly mottled clay. The type occurs principally along the creeks and smaller streams of the county in strips from one-eighth to one-fourth of a mile in width. The narrow flood plain of the Kentucky River has also been included in this type. Owing to the lighter material about the headwaters of this river, as well as the greater sorting power of the larger stream, the soil here is of a more variable texture than that found in the areas bordering the creeks. On the immediate river bank the soil is sometimes sandy, while in other parts of the bottom it may have a heavier texture than the average for the type.

The Wabash silt loam is a sedimentary soil, composed of stream deposits laid down in times of high water. Along some of the creeks it is not more than from 2 to 4 feet deep, resting upon a rock floor which is nearly level with the stream bed. The most of the type is overflowed occasionally, but never during the growing season. Sycamore is the usual timber growth.

Composed, as it is, of wash sediments from the fertile uplands, it is a very productive soil, and is highly esteemed for farming purposes. Practically all of the type is cleared and under cultivation. The larger proportion of it is planted to corn nearly every year, the yield ranging from 40 to 85 bushels per acre. Considerable areas are also devoted to pasture and the production of hay, the usual yield being from 1 to 2 tons per acre, even in an unfavorable year. Sorghum and millet are grown to a small extent. It is often difficult to work the soil early in the spring, thus making the crops later than upon the upland soils. It is difficult to arrive at the value of this soil per acre, as it is seldom sold separately, but it is always considered the most valuable part of the farms upon which it occurs.

The following table gives the average results of mechanical analyses of the Wabash silt loam:

Mechanical analyses of Wabash silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13261, 13778	Soil	1.1	1.8	1.0	1.9	5.1	61.6	27.4
13262, 13779	Subsoil	1.6	2.1	1.3	2.4	4.6	55.6	32.3

DEKALB LOAM.

Excepting possibly the Hagerstown loam and the Wabash silt loam, the Dekalb loam, or "sandstone" land, as it is locally termed, is the most highly esteemed soil in the county. As typically developed the soil is a fine-textured loam of a light-brown or yellowish color, from 10 to 15 inches deep, the immediate surface covering sometimes having a gray, silty appearance. Becoming heavier in texture and lighter in color with increase in depth, it grades into a light-yellow silty clay or clay subsoil, often mottled with gray or drab, which extends to a depth of 3 feet or more and finally passes into a mass of freshly disintegrated sandstone resting upon bed rock. Sandstone fragments are usually scattered over the surface to some extent, and a boring often passes through pieces of partially disintegrated rock. Irregular ferruginous concretions or "iron stones" are sometimes found.

The Dekalb loam is found in the western part of the county, the smaller areas appearing at intervals along the western and northern edges, near the Kentucky River. The largest area is found along Posey Ridge, a high divide between Silver and Paint Lick creeks. The next largest area is found on the ridge between Silver and Tate creeks, commencing about 4 miles west of Richmond. Not infrequently small patches of limestone soil are found associated with the areas of this type.

The Dekalb loam occupies a deeply eroded and dissected portion of the county, although the ridges in some cases are quite broad and gently rolling. The valleys of the small streams flowing through the main areas of the type have exceedingly abrupt terminations and steep sides, and in most cases the soil extends for a distance down these slopes. The soil is well drained, and in some locations washing is likely to occur. The nature of the soil is favorable to the retention of moisture, and it is better able to withstand drought than are the limestone soils.

The Dekalb loam is a residual soil derived from a very fine grained, calcareous sandstone, known as the Garrard sandstone. As shown by chemical analysis, this formation contains a considerable quantity of calcium phosphate, which may account in part for the productiveness of the soil.

This type is considered the best tobacco soil in the county. The yield averages about 1,000 pounds per acre, and its quality is usually superior to that grown on the Hagerstown loam. It is also preferred by many for general farming purposes, since it is easily worked and does not suffer from drought. For permanent bluegrass pastures it does not equal the limestone soils, though there is considerable stock raising upon farms of this type. Corn yields from 35 to 60 bushels, hay from 1 to 1½ tons, oats from 35 to 50 bushels, and wheat about 15 bushels per acre. It is an excellent soil for potatoes, garden vegetables, melons, and small fruits. The value of the Dekalb loam ranges from $30 to $90 an acre.

The following table gives the average results of mechanical analyses of this type of soil.

Mechanical analyses of Dekalb loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13263,13788,13790.	Soil.........	1.7	4.2	1.4	1.6	4.9	59.9	26.1
13264,13789,13791.	Subsoil.....	1.4	3.3	1.4	1.5	5.4	53.6	33.5

DEKALB FINE SANDY LOAM.

The Dekalb fine sandy loam to a depth of from 10 to 16 inches is a brown or light-brown to gray fine sandy loam, underlain by a subsoil which varies from a heavy fine sandy loam to a sandy clay extending usually to a depth of 3 feet. Fragments of sandstone and shale are scattered over the surface and through the soil and subsoil, and sometimes bed rock is found within 3 feet of the surface.

This type occupies the narrow tops of some of the lower mountains, or hills, in the southeastern corner of the county. Its usually rolling topography, together with its high-lying position, insures good drainage. It is a residual soil, derived from weathered sandstone and sandy shale of the Carboniferous period, found capping some of the high, isolated hills or low mountains in this region.

Nearly all of the Dekalb fine sandy loam is cleared and in a cultivable condition. Corn is generally grown four years in succession, and then the land is allowed to remain idle for some time. A yield of from 18 to 30 bushels per acre is usually obtained. It is an excellent soil for small fruits and potatoes, but is little used for these crops.

The following table shows the results of mechanical analyses of the fine earth of this soil:

Mechanical analyses of Dekalb fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13578	Soil	Tr.	1.1	1.0	47.5	9.1	25.9	15.2
13579	Subsoil	0.1	.3	.4	44.0	9.5	24.2	20.5

DEKALB SILT LOAM.

The soil of the Dekalb silt loam, to a depth of from 10 to 16 inches, consists of a light-yellow or yellowish heavy silt loam or silty clay, the immediate surface covering frequently having a light-gray color, especially when dry. The subsoil is a heavy silty clay or clay of a light-yellow color, usually mottled to some extent with gray, and rests upon a bed of black shale a few feet from the surface. Thin layers of hard siliceous concretions are sometimes found within a few inches of the surface.

There are two phases of this type of soil. The first phase consists of areas in which black shale fragments outcrop in spots upon the surface, forming a slaty soil which is more or less mixed with the dark yellow or slightly reddish clay material of the freshly disintegrated rock. Usually these areas are badly washed and are covered with a scrubby growth of timber. These shaly areas are indicated upon the map by the use of symbols. The second phase occurs in small, flat, poorly drained areas where the soil is an ashy gray or dirty white silty clay grading into a heavy gray or drab mottled clay subsoil. This phase of the type has little value even when drained.

The Dekalb silt loam is found only in the southern and eastern parts of the county. In the eastern part the surface of the type is very nearly level, but farther south it becomes somewhat rolling. It also occupies the valley floors in this region. The rolling areas as a rule lie at the foot of the mountains and contain many slaty spots. Except in the rolling areas, the type is not naturally well drained nor does it hold moisture well during a dry season. Crops upon it suffer considerably during a drought. The soil owes its origin to the disintegration in place of thin-bedded black Devonian shales which are quite bituminous in certain sections. The composition of the soil has been influenced to a certain extent by the addition of wash material from higher elevations.

The natural forest growth consists of several species of oaks, besides some hickory, chestnut, and Virginia pine. When first cleared, the soil produces fairly good crops, but it becomes much less productive after two or three years' cultivation. The common practice has been to allow it to lie idle or in pasture for two or three years and then to plant it to corn again. The yield of corn ranges from 10 to 25 bushels per acre, the average being about 15 bushels. Some hay is grown, and a very little grain, principally oats. With good drainage and proper rotation of crops there is no reason why the Dekalb silt loam should not be made a productive soil for various crops. There is often difficulty in securing a good stand of clover, especially in a dry year, so it is not advisable to include that crop in the rotation. Cowpeas, however, will answer the same purpose of supplying humus and nitrogen to the soil, and at the same time will afford excellent feed for all kinds of stock. It is strongly recommended that this crop be more extensively grown upon this soil. During the past few years lespedeza, or Japan clover, has gained a foothold, and besides furnishing good pasture is improving the soil to a marked extent. The value of this type of soil varies from $10 to $20 an acre.

The following table gives the average results of mechanical analyses of samples of the Dekalb silt loam:

Mechanical analyses of Dekalb silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13363, 13771, 13773.	Soil.........	2.0	1.9	0.7	1.3	4.5	70.0	19.1
13364, 13772, 13774.	Subsoil.....	1.2	1.7	.6	1.2	3.3	61.0	30.8

DEKALB SHALE LOAM.

To a depth of from 6 to 9 inches the Dekalb shale loam is usually a light-gray silt loam or clay loam which becomes a dirty white color when dry. The soil grades into a gray, yellowish,or reddish clay subsoil. Light-colored shale fragments are usually present, but because of its position and derivation the type is far from uniform in this respect, even in small areas. On the smoother hillsides adjacent to the valley floors the clay subsoil continues to a depth of 3 feet or more and the shale fragments are not conspicuous. Higher up the slope the shale often constitutes a large part of the soil, and the bed rock is encountered within 18 or 24 inches of the surface.

The type is found principally in the southern and southeastern parts of the county. It occupies very steep hillsides, which are often badly eroded, especially where the forest covering has been removed. The soil is formed by the weathering of a thick stratum of thin-bedded shales of the Carboniferous period, designated as Waverly.

A phase of the Dekalb shale loam occurs in narrow strips in the southwestern and northeastern parts of the county. These areas contain outcrops of calcareous green shale, which in some cases have weathered to a greenish or almost white clay with the characteristics of soapstone, and in other cases have formed a gray sandy soil mixed with numerous shale fragments. Almost without exception the areas are badly washed and gullied and are practically worthless for agricultural purposes, except in a limited way for pasture. A light growth of cedar is frequently found upon this phase of the type.

The Dekalb shale loam is naturally the poorest soil in the county, and for the most part is covered with a growth of small timber, the largest trees having been removed. The most valuable timber is white oak; hickory, chestnut, and scrub pine are also found. Very little of the type is under cultivation, except the small strips forming the edges of the narrow valley floors. Along the hillsides of the Red Lick Valley fair crops of corn are produced, and other crops are sometimes grown with success.

In connection with the Dekalb shale loam, but not as a part of the type, should be mentioned a number of very small areas which play some little part in the agriculture of the so-called mountainous section, but which could not be shown upon the accompanying map because of their small extent. These are steep and very stony areas, seldom more than a few acres in extent, and are found well up on the hillsides directly under the limestone outcrop. The soil is formed by the combined wash material from the limestone and sandstone, or conglomerate which usually lies above it. Upon this dark, productive, sandy soil are found growing papaw, hickory, black walnut, poplar, and "sugar-tree." Where cleared and cultivated it produces from 35 to 40 bushels of corn per acre for a few years, and is then allowed to grow up to bushes for a few years, after which it is again cleared and planted to corn. By judicious management these areas could be made to produce some crop every year.

The following table gives the average results of mechanical analyses of samples of fine earth of the Dekalb shale loam:

Mechanical analyses of Dekalb shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13576, 13775.......	Soil.........	2.5	3.1	0.6	1.2	5.3	65.4	21.5
13577, 13776.......	Subsoil.....	1.8	3.3	.9	1.5	4.9	65.3	22.1

CUMBERLAND LOAM.

The soil of the Cumberland loam is a yellowish and sometimes gray, rather compact fine sandy loam from 10 to 14 inches deep, containing very little humus. The subsoil is a clay or loam of a light-yellow color, usually mottled with gray below 25 or 30 inches from the surface. Occasionally small areas, in the nature of "pockets," of fine yellow sand 3 feet or more in depth are encountered.

This type is found only in the northeastern part of the county, near the Kentucky River, where it occupies a number of rather broad, gently rolling hilltops. Though its surface drainage is not excessive, the soil dries out quickly after a rain and crops are liable to suffer from drought during the summer months.

The Cumberland loam, like two other minor soil types of the area, has been formed by deposition of materials in water rather than by the disintegration of rocks in place. The formation has been assigned, provisionally, to the Neocene age, and consists of unconsolidated stratified sands and clays laid down by the flood waters of an earlier stream than the present Kentucky River, which occupied a much higher, broader, and shallower channel.

Deposits of a superior pottery clay are found within a few feet of the surface in some parts of this formation.

This soil is not very productive, and the use of fertilizers is generally necessary to secure satisfactory crop yields. Under favorable conditions and proper fertilization corn yields about 20 bushels per acre. This is the principal crop grown at present, it being customary to grow corn successively for two or three years and then use the land for pasture for a number of years. As the soil is almost too light for clover, it is advisable to grow cowpeas in its place. Small fruits, berries, potatoes, and all kinds of vegetables do well.

The following table shows the average results of mechanical analyses of samples of the Cumberland loam:

Mechanical analyses of Cumberland loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13703,13798	Soil	0.1	0.9	3.4	18.6	15.7	48.9	12.0
13704,13799	Subsoil	.1	.9	4.6	15.5	10.9	48.2	19.4

GUTHRIE CLAY.

The soil of the Guthrie clay consists of a gray or ashy-gray silt loam varying in depth from 8 to 20 inches. The subsoil is a gray silty clay or mottled gray and yellow clay. Both the soil and subsoil usually contain a large number of small iron concretions. In a few small areas near Moberly and in one or two other places the soil is a very dark brown or nearly black clay loam with a clay subsoil. Large numbers of crawfish holes are found in all parts of the type.

The Guthrie clay occurs in the south and east central parts of the county in connection with the Hagerstown loam. It generally occupies nearly level areas, but sometimes occurs upon hillsides of considerable inclination. For the most part its natural drainage is poor, and the soil is in an acid condition. The heavy texture of the subsoil prevents the ready movement of water through it, thus giving rise to the poor drainage conditions.

This type is derived principally from some of the top portions of the Richmond formation, which have not been calcareous enough to weather down into a characteristic limestone soil.

Fairly good crops of corn are produced on this soil, the yields usually ranging from 20 to 35 bushels per acre. Aside from this its use is largely as pasture land. Grass does very well upon it in the early spring, but dries up during the summer months. Drainage, either by open ditches or by tile drains, and applications of lime would greatly improve the physical condition of the soil. It needs barnyard manure to increase its organic matter content, and the growing of cowpeas is also recommended.

The following table gives the average results of mechanical analyses of samples of the Guthrie clay:

Mechanical analyses of Guthrie clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13608,13796	Soil	9.1	5.7	0.7	2.5	8.9	59.8	13.2
13609,13797	Subsoil	6.5	5.0	.8	2.3	8.3	60.5	16.1

MUCK.

The occurrence of Muck, locally known as "glade," is limited to a few small flat areas in the vicinity of Berea. To a depth of from 12 to 18 inches it consists of black organic matter containing a considerable admixture of earthy material. This is underlain by a heavy plastic brownish or drab clay, which becomes mottled with iron stains below 28 or 30 inches from the surface. The water table is usually within 3 or 4 feet of the surface even in the driest seasons.

The origin of the Muck is no doubt due to the existence in comparatively recent geological time of a body of water over the present areas. The fine clay sediments of the subsoil were deposited in this water, and the organic matter represents the decayed remains of vegetation which later obtained a foothold over the areas. Erosive agencies finally opened an avenue of escape for the water, and at present streams flow in two directions from the main Muck area.

Early attempts to grow crops upon this soil failed because of the deficient drainage and the acid nature of the soil, and it was considered almost worthless except for a limited amount of pasturage. A part of the Berea College farm located upon the type has been brought to a state of productivity by thorough tile drainage and the application of lime. At the present time these reclaimed areas will produce from 35 to 45 bushels of corn per acre.

ROUGH STONY LAND.

The areas classified as Rough stony land consist partly of a line of rocky bluffs found along the Kentucky River in the northwest corner of the county. These are so steep and are covered with such a thin mantle of soil that they are worthless for any agricultural purpose. They are usually covered with a scrubby growth of timber. Other areas of Rough stony land, too small to be shown on the map, occur on the steep hillsides in connection with the Hagerstown stony clay. Areas of Rough stony land are also found about the tops of some of the mountains, or high isolated hills in the southern part of the county. The massive limestone of these areas has broken into various sized bowlders which are strewn along below the outcrop. The soil derived from the limestone is a very productive red clay, and small fields are sometimes planted to corn with excellent results. These areas were originally heavily forested.

RIVERWASH.

Along a few of the larger streams within the county, notably Tate, Silver, Otter, and Paint Lick creeks, a few small areas are mapped as Riverwash. These are almost completely covered with waterworn rocks and small limestone slabs transported and deposited by the streams in times of flood. This material usually rests upon a solid limestone floor. Occasionally a small patch of soil is found, but upon the whole the areas are worthless even for pasture.

AGRICULTURAL METHODS.

The system of agriculture and methods of cultivation now prevailing in Madison County are those which have been practiced for many years. While there are a great many farmers who are probably securing as large returns as is consistent with a proper maintenance of the productivity of the land, there are also a large number who are either not securing the best results or are allowing their farms to run down. In many cases the farmers have depended too much upon the natural productiveness of the soils, especially the limestone soils, and have neglected proper precautions to maintain the crop-producing power of the fields. There is little question that the productivity of most of the soil types can be permanently maintained, and in many cases increased, by the proper rotation of crops and the intelligent handling and application of such manures as are available.

Corn is the most important cultivated crop, and in many cases it has been grown upon the same land for several years in succession. This practice, however, is not so prevalent now as in former years. Except possibly upon some of the bottom lands, corn should not be grown continuously upon the same field except in rotation with other crops. Successive cultivation to this crop not only causes a decline in the productiveness of the soil, but also gives greater opportunity for the increase of the insect pests and diseases, which also lower the yields.

To prevent corn fodder from molding, it is generally necessary to cut it very late, after the leaves are dried up, and thus much of its feeding value is lost. The fodder is left in the field in large shocks and hauled and fed as needed through the winter months. The winters are often wet and comparatively warm and much of the fodder is spoiled and wasted. Upon a large number of farms where cattle are raised the better plan would be to grow fodder corn and store it in a silo for winter feed. By this method there is no loss of nutriment and the entire stalk is readily eaten by cattle. The loss in grain caused by sowing the corn thickly would be offset by the increased amount of fodder produced. A more careful selection of seed corn is also recommended.

It is the general custom to sow wheat upon corn land after the fodder is cut in the fall, without preparation of the land other than that given by the drill or harrow. The average yield of wheat per acre has decreased during the last few years, owing in a great measure to insufficient preparation of the land. The wheat is often of a somewhat inferior quality, but this or some similar crop is necessary to prepare the land for sowing grass after it has been planted to corn. Since one year in the rotation should be devoted to this crop, it should be made to produce as heavily as possible by thorough preparation of the seed bed. The increased yield of the crop and the benefit resulting to the soil from a more thorough preparation of the wheat land would, it is believed, more than pay for the added labor.

The rotation usually practiced by the best farmers consists of corn, wheat, clover, and then hay or pasture for a number of years. Clover should be grown at least every fifth or sixth year. Rye is sometimes sowed in the fall and plowed under in the spring. Care should be taken to do the plowing before the rye becomes too large, since if plowed when too high it makes the soil too loose. Alfalfa would probably prove a success upon the Hagerstown loam, Dekalb loam, and Wabash silt loam, and also upon the better areas of the Hagerstown clay. Its feeding value, as well as its beneficial effect upon the soil, is unquestioned.

In the eastern and southeastern parts of the county a systematic rotation of crops should be followed and better methods of cultivation practiced, besides applying all the manure possible. It is recommended that cowpeas be given an important place in the crop rotation. Lime in considerable quantities is also essential to successful crop production upon some of the soils in this region.

Tobacco should be planted on sod land as a rule, and followed by a crop of small grain. Successive crops of tobacco should not be grown except upon land recently cleared. It is believed that the growing of both tobacco and hemp more extensively on the Hagerstown loam would prove profitable. At present the largest acreage of tobacco is upon the steep hillsides in the western part of the county. Many of these hillsides have been cleared but a comparatively short time, and their virgin soil is well suited to tobacco. No fertilizer is used in growing this crop. Continuous cultivation of both tobacco and corn upon these hillsides is depleting the humus of the soil and causing serious erosion in many places. Unless more care is used upon the farms in this part of the county a few years more will find them much reduced in value.

Proper attention has not been given to the question of erosion on many of the farms in the area surveyed, and this neglect results in much loss every year. Even such simple methods as deep plowing and leaving a narrow strip of unplowed land, or plowing a back furrow as a contour line along a hillside, will serve to prevent much damage.

Under the system of crop rotation generally followed, much of the land is plowed but once every five or six years, and unless this one plowing is very thorough it does not pulverize the soil properly nor prevent it from becoming too compact. The Hagerstown loam, Dekalb loam, and Wabash silt loam all admit of deep plowing, and in many cases subsoiling would be beneficial.

As a rule no shelter is provided for stock during the winter, and very little barnyard manure is saved and applied to the soil. It is believed that in many cases stock is allowed to run upon the fields too early in the spring, thus puddling the soil and making it more likely to bake hard during the summer months.

The cattle raised are mostly of the Shorthorn breed. Some corn is used for fattening the beef cattle. The extent of pasture allowed for each 3-year-old steer varies from 2½ to 5 acres, according to the season and the character of the land. Where land is valued at $100 an acre this method of using it does not yield very large returns upon the money invested.

AGRICULTURAL CONDITIONS.

Taken as a whole, the farmers of Madison County are in a prosperous condition. The degree of prosperity varies in different parts of the county, owing principally to differences in the soils. Over the greater part of the county the farm dwellings are neat and well built, especially upon the Hagerstown loam areas, but except for an occasional tobacco barn the outbuildings are small. The farms are usually well fenced. Comparatively few of the farmers are burdened with debt.

The most striking departure from the general state of prosperity is found in the southeastern part of the county, which includes a slightly mountainous section. It is not often that a contrast is so great as that which is presented in the short distance between this section and the bluegrass lands of the county. The eastern section of the county is likewise not so favored by natural conditions as is the larger part of the county, but by intelligent management, good cultural methods, and proper rotation of crops many of the poorer farms can be made productive and profitable.

About 65 per cent of the farms in Madison County are operated by their owners. Many tracts of the Hagerstown loam are held by persons residing in Richmond or outside the county. Many owners reside upon their farms and rent the land to tenants. The share and the cash-rent systems are both practiced. The amount of rent depends not only upon the desirability of the land, but also upon the crop to be grown. Good pasture land rents for from $4 to $6 an acre, land for corn and hemp for from $7 to $10, and for tobacco for from $12 to $18. The latter crop is usually cultivated on shares. In the eastern section of the county the cash rents are much lower, averaging from $3 to $5 an acre, and much of the renting is done on the share basis. The desirability of the farms through the central part of the county is such that a tenant can always be easily found.

The size of the average farm is about 100 acres. In the central part of the county there are several holdings of from 300 to 500 acres, and some of the wild land in the southern end of the county is held in even larger tracts. In 1900 the average valuation of the improved farm lands in the county was about $27 an acre, but since that time it has increased probably by 20 per cent.

The prevalence of stock raising over a large part of the county and the large acreage devoted to pasturage has made the labor problem less important than is generally the case in agricultural communities. Negro labor is mainly employed and is generally satisfactory. The wages paid vary from $13 to $18 per month, without board, but including a dwelling and fuel. Laborers hired by the day receive from 60 cents to $1.20. Negroes compose about one-sixth of the population of the county.

The principal industry in Madison County is stock raising. According to the census of 1900 the value of live stock was $1,719,462. The stock consists principally of heavy export steers but also includes large numbers of hogs, sheep, mules, and some thoroughbred horses.

Of the cultivated crops corn is the most important. The average yield for the county is about 30 bushels per acre. The yield in the bluegrass section is above this, but is offset by the lower yields in the eastern part of the county. The value of the wheat and tobacco crops was about equal in 1900, but at present that of the latter is the greater. The large number of new tobacco barns seen in the county indicates that the farmers intend to grow tobacco more extensively. White Burley is the most suitable and profitable variety, but some red Burley is also grown. A lack of competition among the buyers has resulted in low prices for a number of years, and at present an independent farmers' organization is being perfected to control the marketing of the crop. Some rye, oats, millet, sorghum, and potatoes are grown, but these are not important products. Sufficient fruit is grown for home consumption and to supply the local market at certain seasons of the year. The hemp crop is limited to a few hundred acres. While both clover and timothy are grown for hay, the latter is not in special favor, since when cut it leaves a rather bare, open stubble which does not later supply good pasture if the season be at all dry. Considerable bluegrass seed is harvested. Little dairying is done, except for the local market Some forest products are shipped from Berea.

As a rule, the crops best suited to the various soils are now being grown upon them. The Wabash silt loam is best suited for corn, timothy, oats, sorghum, alfalfa, and pasture. The Hagerstown loam is adapted to a wide range of crops, including corn, wheat, oats, rye, millet, tobacco, alfalfa, clover, hemp, hay, and pasture. The Dekalb silt loam should be principally devoted to corn, oats, pea-vine hay, sorghum, vegetables, pasture, and the raising of young stock. Upon the Cumberland loam should be grown corn, rye, oats, vegetables, pea-vine hay, berries, and fruits. The Dekalb loam will produce corn, wheat, oats, rye, tobacco, potatoes, hay, alfalfa, melons, vegetables, and fruits. The Hagerstown clay should be confined principally to corn, tobacco, hemp, oats, hay, and pasture.

The county is favored with excellent transportation facilities. A main line of the Louisville and Nashville Railroad between Cincinnati and Knoxville crosses the area from north to south, while a branch line from a point below Richmond reaches the southwest corner of the county. The Louisville and Atlantic Railroad passes through the area in a northwest and southeast direction. Excellent macadam roads radiate in many directions from Richmond and are being added to every year. The heavy clay subsoil makes some of the crossroads difficult to travel during wet weather. At the present time there is no direct means of communication between Richmond and Lexington, but it is expected that an electric railway line will soon connect these two points.

Cincinnati, 112 miles distant, is the nearest market of any size. To this city many of the lesser products of the county, such as poultry, calves, hogs, light cattle, etc,. are shipped. The heavy export cattle are shipped direct to Jersey City or some other eastern point. Richmond furnishes a local market for the fruits and dairy products of the county, and on the monthly "court day" mules, sheep, horses, and cattle are brought to this place and disposed of either at auction or by private sale.

SOIL SURVEY OF M'CRACKEN COUNTY, KENTUCKY.

By THOMAS D. RICE.

LOCATION AND BOUNDARIES OF THE AREA.

McCracken County comprises an area of 155,136 acres or about 242 square miles, situated in the western part of Kentucky. It is included between the parallels of 36° 56′ and 37° 12′ north latitude and the meridians 88° 30′ and 88° 52′ west longitude. It is bounded on the north by the Ohio and Tennessee rivers, on the west by Ballard County; on the south an east-and-west line divides it from Graves County, and on the east it is separated from Marshall County by a north-and-south line. Paducah, the county seat and the only important town, is advantageously situated at the junction of the Ohio and Tennessee rivers.

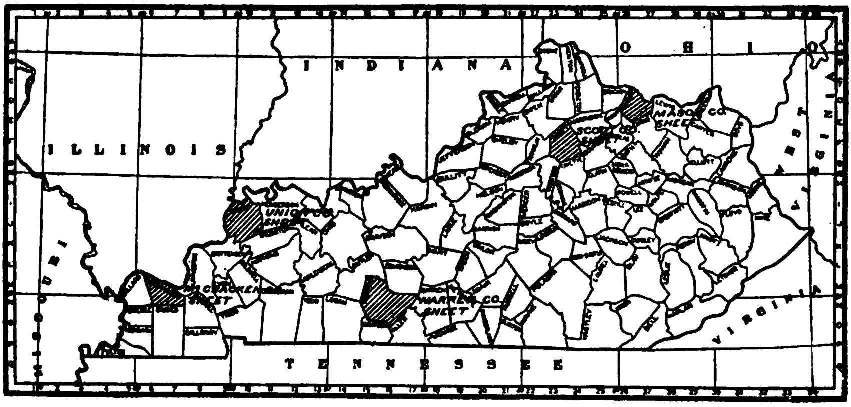

FIG. 28.—Sketch map showing location of the McCracken County area, Kentucky.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The western part of Kentucky was secured to the United States in a general way by the expedition led by George Rogers Clark, during the Revolutionary war, but no attempt was made to occupy the country for many years after the close of the war and the region remained in possession of the Indian tribes. The area now forming McCracken County was a part of what is known as the Jackson Purchase. The Purchase, embracing in Kentucky the land lying between the Tennessee and the Mississippi rivers, was bought, in 1819, from the Chickasaw Indians and opened to settlement. McCracken County, at first a part of Hickman County, was given a separate government in 1824. Gen. George Rogers Clark, on account of his valuable services during the Revolutionary war, was granted by Congress two tracts of land in the Purchase, one of which embraced the greater part of McCracken County, including the present site of Paducah. This tract was supposed to contain 37,000 acres of land, but by actual survey it was found to cover an area of twice that size. The land soon passed out of the possession of General Clark and his heirs, and was opened to settlement by the public.

The early settlers of this part of Kentucky were for the most part from Virginia and Maryland, with a smaller proportion from Pennsylvania and the Carolinas. Among the immigrants of later arrival who contributed much to the welfare of the county were the Germans who settled in the southern part of the county. Though the land first taken up by them was probably the least productive in the area, they have through industry and patience been uniformly successful in their farming.

Nearly all the early settlers were familiar with the cultivation of tobacco, and this product has from the beginning been the chief money crop of the McCracken County farmers. For breadstuffs the early settlers grew corn and small grains, while the hogs and cattle, kept on the public ranges, furnished them meat at small cost.

The agricultural history of this region has been uneventful, from the first attempts to cultivate the soil to the present day. Corn, tobacco, and wheat have been the staple crops, though the relative acreage devoted to each crop has fluctuated according to prices and changing conditions. In recent years there has been a tendency to make tobacco a less important crop, as the low price of the product and the decrease in the yield on a large part of the lands have caused the farmers to consider the advisability of practicing a crop rotation to maintain the productiveness of lands in cultivation and to improve those already exhausted by the continuous cultivation to one crop. This has resulted in the practice, now becoming general, of rotating with cowpeas to improve the soil, and the results obtained from the practice are such as to justify its continuance.

The increase in population and wealth of the county has furnished the farmer a growing market, and the demand for agricultural products has equaled the production. When the river was the only avenue of transportation, the advantageous site of Paducah naturally made it one of the most important towns of western Kentucky, and it has always enjoyed a large share of the river commerce. Since the railroads have taken much of the traffic that formerly belonged to the river, such lines have been laid into Paducah from all sides and the farmers have profited by abundant transportation facilities. In 1853 the first railroad through McCracken County was projected under the name of the New Orleans and Ohio Railroad. This road is now a part of the Nashville, Chattanooga, and St. Louis Railway. In 1872 the Paducah and Elizabethtown Railroad, now known as the Illinois Central Railroad, was completed to Paducah. The line connecting Paducah and Cairo was completed in 1904 and became a great convenience to the farmers of the western part of the county.

CLIMATE.

The tables given below show the normal monthly and annual temperature and precipitation for Paducah, in McCracken County, and Blandville, in Ballard County. As these stations represent the extremes of elevation and distance from the rivers the figures compiled here may be safely taken to represent the average climatic conditions of McCracken County. The annual mean temperature, as shown by these tables, is nearly 60° F. The heaviest rainfall is likely to occur in the early summer and short droughts are expected during the fall months, but extremes are very rare.

Normal monthly and annual temperature and precipitation.

Month.	Paducah.		Blandville.		Month.	Paducah.		Blandville.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitature.
	°F.	*In.*	*°F.*	*In.*		*°F.*	*In.*	*°F.*	*In.*
January	37.2	4.02	34.9	4.52	August	80.6	2.90	77.6	1.78
February	36.2	3.62	33.1	3.19	September	73.9	3.17	70.8	3.25
March	49.5	4.76	47.1	5.33	October	61.8	2.40	59.4	2.67
April	59.4	4.05	55.9	3.60	November	49.4	4.05	47.0	3.51
May	69.9	3.87	67.3	3.87	December	38.9	3.63	36.2	4.14
June	77.8	5.33	75.1	5.07					
July	81.3	3.75	78.2	4.20	Year	59.6	45.55	56.9	45.13

Data relative to the dates of the latest and earliest killing frost in spring and autumn show that at Paducah there are, on an average, 207 days free from frost. At Blandville, owing to its elevation, the average is less, 196 days being frostless. This gives a growing season generally of sufficient length for all crops attempted in this latitude. When the tobacco crop is late, however, it is sometimes caught by an early frost, but this is of rare occurrence. Peaches are uncertain, owing to the frosts occurring late in the spring.

The climate is reasonably even and pleasant. The springs and autumns are long and delightful. In the uplands the healthfulness of this region is unsurpassed. In the comparatively small bottom land areas malarial disorders are prevalent, particularly in the more unsettled districts. This condition will doubtless disappear wholly or in part as the bottom lands are drained and brought under cultivation. as this has been the usual history of such districts elsewhere.

PHYSIOGRAPHY AND GEOLOGY.

The surface of McCracken County may be divided into two physiographic divisions—the uplands, occupying the greater proportion of the area, and the comparatively narrow bottoms extending as strips along the larger streams. The uplands rise abruptly from the rivers or their low-lying flood plains to a height of 40 to 50 feet near the streams, and attain a height of more than 100 feet above river level in some parts of the county. These uplands vary in topography from sharply rolling hills, with occasional steeply eroded sides in the southwestern part of the county, to stretches of nearly level land several square miles in extent, most common in the eastern side of the county.

The surface material of the uplands, and the formation from which the soil is almost entirely derived, is a yellow unconsolidated silt or its weathered product. This silty material, to which the term loess has been applied, is widely distributed over the Mississippi Basin, as well as over the Rhine Valley in Europe, and large districts in China. The vast extent of the deposits, its uniformity, and the lack of well-marked stratification lines have involved its origin in doubt, and the probable manner of its deposition is still a matter of contention among geologists. It is certain that the loess was assorted by either wind or water, or both, during the glacial period, from the mass of material left over regions to the north of this area at the time of the retreat of the ice sheet. Whether the silty loam of the area is derived from the original deposit or from some of the material that was transported and redeposited is immaterial, but it is evident that the loess mantle was of a general uniform thickness, as it covers hilltops and valleys to a depth of 6 to 10 feet. The loess rests unconformably on a bed of reddish-brown gravel or coarse, loosely cemented conglomerate. This lower stratum enters but rarely into the composition of the surface soil, as it is only exposed in narrow bands along the deeper stream slopes.

The second physiographic division of the area includes all the alluvial lowlands. Of these two subdivisions have been made, based on the character of the prevailing soils. The heavier type of soil, to which the name Waverly clay has been given, occupies a strip of uniform width along almost the entire course of the Ohio River and extends a short distance up the Tennessee River. These rivers bring their sediments from great distances, and they are made up of a great variety of materials, so that the heavy clays deposited over these bottoms are distinctly different from the deposits of the smaller streams. The lighter soil is found along the smaller streams, the largest area of which follows Mayfield Creek in its course through the county. This type is of more local derivation and consists largely of reworked material from the silt-covered uplands. Both of these soils are of very recent age, and, except on the higher bottoms, they are yet in the course of deposition, as fresh accretions of soil are obtained from the sediments of the streams in every time of flood.

The rainfall over McCracken County is drained off in three portions, which find their way, respectively, to the Tennessee, the Ohio, and the Mississippi rivers. Of the smaller streams only Mayfield Creek and Clarks River maintain their flow throughout the year, and both of these have their source outside the county. The local drainage is effected by a number of small intermittent streams, which become dry after a short period of drought. There is sufficient slope to provide ample drainage for all parts of the area, though the drainage of some of the more level lands must be assisted by surface ditches. The small streams are not cutting back into the hills with great rapidity, which is extremely fortunate, as the loess succumbs rapidly to running water, and in other localities where this material is found washing and gullying have progressed to such an extent that the protection of the farming lands is a very serious problem. In McCracken County it is only necessary to keep the land well covered with vegetation and exercise a little care in dealing with the washes that start on newly plowed land, to hold the soil intact.

SOILS.

The soils of McCracken County have been divided into three types—one upland type, called the Memphis silt loam, and two alluvial types, the Waverly clay and the Waverly silt loam.

The area of each soil and the percentage of the total area are given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.
Memphis silt loam	139,776	90.1
Waverly clay	9,536	6.1
Waverly silt loam	5,824	3.8
Total	155,136	....

MEMPHIS SILT LOAM.

About 90 per cent of the surface of McCracken County, comprising the whole of the upland, is covered by the Memphis silt loam. The soil, to a depth of 8 to 12 inches, is a silt loam, composed mainly of silt with smaller percentages of clay and fine sand. The textural difference between soil and subsoil, to a depth of 3 feet, consists of a small increase in the clay content and a decrease in the amount of the various grades of sand. In color the top soil is brown and in some places a chocolate brown, owing to the presence of organic matter. The subsoil has a characteristic yellow, and at a depth of several feet it is often of a reddish-yellow color. When dry, the Memphis silt loam crumbles readily to a floury material. It dries rapidly and the roads become dusty shortly after rains wherever drainage is at all facilitated. When wet, the soil is slightly plastic and sticky, but does not have the properties of a clay. One of the characteristic features of the Memphis silt loam is its remarkable imperviousness. The common method of providing water for stock is to scrape out a reservoir on the surface and slightly puddle the sides and floor, though no special attention is paid to this part of the work. This pond fills during the rainy seasons and furnishes a supply of water for the stock sufficient to carry them through any ordinary drought. There is practically no underground drainage from the reservoirs and the only waste comes by evaporation. When plowed wet, the soil clods to some extent, but when worked in the proper condition, no difficulty is experienced in preparing the land. The soil often assumes a granular condition after plowing that gives it the appearance of being a coarser material than it really is, but it may be easily reduced to a silty powder. There are few localities in the area where iron stains and iron concretions may not be found in the subsoil, and they are abundantly distributed through the subsoil in those localities where drainage was originally poor. This would seem to indicate an excessive amount of iron in the Memphis silt loam of this area, but the accumulations are seldom in the form of crusts, hardpan, or other large bodies of ferruginous material, and never in such quantity as to interfere with the cultivation of the soil. The Memphis silt loam is uniform in texture over the whole area. The only differences to be observed are those due to the varying proportions of organic matter or to drainage conditions. Over a large part of the area, where drainage was originally poor and the humus content small, the soil is of a pale yellow or white color and the subsoil white mottled with drab, containing many iron concretions. Everywhere, at a depth of from 6 to 10 feet, the Memphis silt loam is underlain by beds of gravel or loosely-cemented conglomerate. The gravel strata are rarely exposed, except in deep and narrow stream channels or on the slope toward the Ohio River, and the areas of soil derived from these outcrops are never of sufficient extent to be of any agricultural importance and have therefore not been indicated on the soil map.

The Memphis silt loam occupies a large area in western Kentucky, stretching beyond the limits of McCracken County toward the southeast and west. It is the most important soil of the county, as it occupies the whole area, except narrow strips of alluvial soil along the larger streams.

The topography of the Memphis silt loam varies from rolling hills, with many precipitous slopes, in the southwestern part of the county, to the "flat woods" of the eastern and central parts, in which areas of several square miles have barely sufficient slope to remove the surface water. In the hilly section the land washes and gullies where hillsides are left exposed, but the excessive erosion resulting in great bluffs and the perpendicular weathering characteristic of the areas of this type in Mississippi are not seen in McCracken County. The small creeks that drain the greater part of the area are not cutting their channels very rapidly, and some have reached an appearance of maturity. By means of surface ditches the entire area may be drained toward these streams without danger of rapid washing. The surface of the land may be protected from gullying by keeping it well sodded with lespedeza and the native grasses. Uncultivated lands, where well forested or covered with vegetation of any kind, are amply protected against washing, but the farmer in the hill section must constantly guard against gullies starting in his plowed land.

The Memphis silt loam is the product of the weathering of a vast sheet of silty material, known as loess. That the deposit of this material was remarkably uniform in texture and maintained a general uniform thickness is evident from the character and depth of the soil. Over a large part of the county the material has evidently weathered in the position of its original deposition at the close of the Glacial period, but over a smaller part the silt has washed into the depressed localities and formed many, but perhaps not all, of the flat level areas.

A large proportion of the area of this type has never been cleared of its original forest growth. The largest solid bodies of timber cover the level stretches in the eastern part of the county and the steeper hill slopes to the south, where farming would not be advisable, but there is scarcely a farm that does not have considerable acreage of woodland. The forest growth consists of the common varities of oak and hickory, with a scattering growth of sweet gum, tulip, elm, maple, and chestnut. The hickory thrives especially well on the Memphis silt loam and bears heavily. A few pecan trees grow wild and bear well, but this tree is better adapted to the bottom lands.

The Memphis silt loam has never been classed as a very productive soil for purposes of general farming in comparison with the sedimentary lowland types of this section, but it has always supported a fairly prosperous population. When crop yields are considered, it ranks above the average in agricultural value, and in many sections would be a very desirable type of soil. It has never yet been necessary to make use of commercial fertilizers, as the soil responds readily to green manuring and stable manure,and these have been found efficient in maintaining the productiveness of the soil sufficiently to grow the crops common to this locality.

Tobacco is the principal money crop, though some corn and pea-vine hay is exported nearly every year. A satisfactory yield of tobacco is from 800 to 1,200 pounds per acre. The price varies so greatly from year to year and the quality is so important a factor that no definite idea can be gained as to the average profits, but usually 6 to 10 cents can be obtained for a good quality, and, as no expenditure is made for fertilizers, it will be seen that the tobacco grower of this part of the State is quite as well off as the majority of growers throughout the country. The average yield of corn is good, as few failures result from any cause. Good crops yield from 25 to 40 bushels, but the average yield for good and poor farmers is below the former figure. Wheat is grown to some extent, but the average yields are small. The crop that is probably grown with greatest profit to the farmer, all things considered, is the cowpea. It is grown to provide feed or pasturage and to improve the condition of the soil. The usual procedure is to cut the vines for hay and leave the roots in the ground. It has been the general experience that this method is preferable to that of plowing under the vines.

Where the Memphis silt loam is left uncultivated it is soon covered with a growth of vegetation that furnishes good pasturage. The soil seems especially adapted to the so-called Japan clover, or lespedeza, which, if not kept down by the cattle, will grow more than a foot high and might be cut for hay, though this is seldom done.

A considerable dairy business is done near Paducah on this type of soil. Market gardening is also carried on to supply the city markets. Some attempt is made to hasten the spring crop by keeping the soil as warm as possible by thorough drainage, and tile is sometimes used for this purpose. No attempt has been made to grow vegetables on a large scale for distant markets.

The growing of fruit on the Memphis silt loam has not been attempted with any system, but the soil seems well adapted to many fruits, especially the apple. Orchards, though neglected and uncultivated, sometimes give results which indicate that a well-cared for apple orchard would be very profitable.

The farmers of the area are much interested in the possibility of growing alfalfa on the Memphis silt loam. One small field of alfalfa near Heath is in a most flourishing condition. Other farmers who have tried to grow it report a failure to secure a stand, so it can not be said with certainty that alfalfa would be wholly successful on this type of soil. There is nothing in the texture of the soil to prevent success, and the farmers should persevere in their efforts to secure a stand of this valuable plant on their farms.

The following table shows the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Memphis silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13365	Soil	0.2	1.1	0.6	1.2	3.5	78.3	15.0
13366	Subsoil	.4	2.1	.8	1.0	2.9	68.7	23.9

A study of the manurial requirements of this soil was made by the paraffine-pot method. For this purpose a sample was selected from a field 2½ miles east of Woodville. At this place the soil is a dark-brown silt loam, containing a considerable amount of finely divided organic matter with a yellow silt loam subsoil.

The field from which the sample was taken has been under cultivation for more than fifty years, the principal crops being corn, wheat, and occasionally tobacco, with poor crops of cowpeas in recent years. The soil is considered run down, and the yields are unsatisfactory. Results obtained from this examination indicate that an excellent increase in productiveness may be obtained by heavy applications of manure, and that a large increase may be secured by the use of nitrogen, nitrate of soda, or cowpeas or alfalfa. The use of lime gave a small increase, but no increase was obtained by the use of either potash or phosphates.

In these tests wheat plants were used as an indicator, and the results are not held to be applicable to other and unrelated crops or to fields which have received treatments essentially different from that from which the sample was taken. In general, however, they agree with the best farm practice and are, it is believed, applicable to a large part of this type of soil in the areas.

WAVERLY CLAY.

The Waverly clay is the soil of the bottoms formed by deposits from the Ohio and Tennessee rivers in times of overflow. A soil deposited in this manner and derived from the various sources that supply the upper reaches of the rivers with sediment is naturally variable in texture. In general, however, the typical soil of these river lands may be described as a brown clay, somewhat loamy, with an average depth of 15 inches, underlain by a light-colored clay with a larger proportion of clay and silt. Iron concretions are numerous throughout the soil and subsoil, being more abundant in localities where the drainage has been by some means obstructed. Near the Ohio River the newly formed portions of this type sun-crack when drying and break up into blocks several inches in diameter.

The river bottoms covered by the Waverly clay are a series of terracelike formations having an elevation of from 4 to 40 feet above the mean river level. The greater proportion of these river lands is subject to overflows which are of almost annual occurrence in the winter or early spring. It is seldom that floods damage the growing crops, but the spring floods saturate the soil, and in the absence of adequate drainage facilities often hinder the spring planting in the lower bottoms. Some of the highest land of this type is now above the line of high water, and an area of perhaps one-fourth of the bottoms is seldom flooded.

The several terraces were formed at different times in the history of the river, but all are of very recent age from a geological standpoint. As the river has cut its channel deeper, the lands, once low-lying flats subject to frequent overflow, have been left in their present position, where they are seldom if ever flooded.

The low-lying bottoms, flooded periodically and poorly drained, for the most part are still uncleared. A very heavy growth of oak, hickory, gum, and tulip covers the land, and near the streams there are considerable bodies of cypress timber. One of the principal reasons for the uncleared condition of these lands is the prevailing idea that the bottoms are not healthful. The prevalence of malaria in the lowlands shows that this idea is well founded, but it is very likely that these conditions will be greatly improved when the bottoms are cleared and fully drained.

The Waverly clay is naturally the best soil of the county, and nearly the whole of the area of this type will be brought under cultivation in the near future. The prices of both the cleared and the uncleared bottoms have greatly increased within the last few years, which indicates a growing recognition of the agricultural value of this soil.

Corn is the principal crop grown on the Waverly clay and the yields are uniformly large. A yield of 40 to 50 bushels is not uncommon. Cowpeas are extensively grown, either separately or by sowing between the corn rows, though the latter practice is not always best, as the vines make a very rank growth on this soil. Some tobacco is produced, but while the quantity is large the quality is not usually first class. The Waverly clay is adapted to a wide range of general farm crops, and while all crops of the area do well on the bottoms, it is simply a question with the farmer of growing the most profitable. Watermelons, sweet potatoes, and all vegetables that are favored by a heavy loam do well on this type of soil.

The following table shows the average results of mechanical analyses of typical samples of the soil and subsoil of the Waverly clay:

Mechanical analyses of Waverly clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13616, 14044	Soil	0.1	1.0	1.7	5.5	8.1	49.5	33.9
13617, 14045	Subsoil	.1	.7	.7	2.9	4.9	54.1	36.4

WAVERLY SILT LOAM.

The very silty bottom lands that usually occur within the Memphis silt loam areas and owe their origin to the wash from the loess hills have been correlated with the Waverly silt loam, a type first encountered in Mississippi. In this area the Waverly silt loam consists of a silt loam to a depth of more than 3 feet, there being little difference in texture between soil and subsoil. In color, however, at lower depths the soil changes from gray or dark brown to nearly white or more often white mottled with drab. Numerous iron stains and iron concretions occur below the surface foot, and in the more poorly drained localities the iron accumulations are found in thick masses.

The Waverly silt loam occupies the valleys of the smaller streams, the largest and only important area occurring along Mayfield creek, which skirts along the southern boundary of the county. Along the small creeks the Waverly silt loam passes gradually into the Memphis silt loam, but the area of the type along Mayfield Creek, occupying as it does a depressed flood plain, is more distinctly a river deposit, and is more sharply separated from the soil of the uplands. The soil is nowhere as heavy in texture as the typical soil of the Ohio River bottoms and is much more uniform. The only exception to this uniformity are the strips of gravelly soil near the bluffs, where the gravel deposits underlying the loess have been washed down into the lowlands. These strips are narrow and of no agricultural importance.

The Waverly silt loam, wherever found along the smaller streams, is well drained, and only the areas near stream channels are subject to overflow when the streams are swollen. The Mayfield bottoms are more level and drainage is somewhat difficult. The cultivated bottoms are flooded in season of excessive rainfall by the overflow of the creek, and drain off slowly, so that the spring plantings are sometimes delayed, but a failure of crops from this cause is very rare. The lower lying bottoms are elevated but slightly above the level of the stream and are, for the most part, still uncleared. Mayfield Creek meanders through this low flood plain forming the oxbows and cut-offs characteristic of this topography, and overflows the lower levels after every heavy rain. The low flats, comprising about one-fourth of the land deposited by Mayfield Creek, are not suited to general farming, but there is much of the higher land subject to only occasional overflow that will be cleared and brought under cultivation and make valuable farming land. This land is at present covered with a dense growth of oak, sweet gum, hickory, tulip, and cypress. The expense of clearing the densely timbered areas has had much to do with the slowness of bringing them under cultivation, but as the price of land is advancing it is probable that these lands will be cleared more rapidly. A number of sawmills are in active operation cutting out the valuable timber.

In productiveness and general agricultural worth the Waverly silt loam ranks second to the best of the Ohio bottoms. The principal crops grown are corn, wheat, cowpeas, and tobacco. Corn is doubtless the most profitable crop, as failures are rare and the average yield is good. Forty bushels of corn per acre is considered a satisfactory yield, but larger yields are frequently made. The average is about 30 bushels per acre. Tobacco makes a rank growth and produces a greater weight per acre than the uplands, but this increase is usually at the expense of the quality. Cowpeas are extensively grown as in other parts of the county for their feeding value and their beneficial effect on the soil. A large part of the cleared area of the Waverly silt loam and the whole of the wooded portion is devoted to pasture, and the cattle find good grazing on the lespedeza and native grasses.

Alfalfa has never been tried on the Waverly silt loam in this area, so it can not be said that this crop would be successful, but it is probable that it would do well on the better drained portions of the type.

The following table shows the results of mechanical analysis of the soil and subsoil of the Waverly silt loam:

Mechanical analysis of Waverly silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14043	Soil	1.1	3.0	2.3	4.1	3.5	65.6	20.1

AGRICULTURAL CONDITIONS.

McCracken County has always borne an unfavorable comparison with the surrounding counties that have a larger proportion of alluvial land, but when we consider the total agricultural wealth of the county and the yield of the soil, when compared with the average for the entire country, it will be seen that this depreciation is, to a large extent, unmerited. The average production is good, crop failures are rare, the average wealth per capita of the farming class is high, and the farmers are now enjoying a period of great prosperity. One of the most noticeable indications of the latter fact is the large number of new houses that are being built throughout the country. New land is coming into cultivation, and the price of farm property is steadily rising. More money is spent on public improvements, and the country roads are being rapidly brought into a condition befitting the wealth and ability of the county.

The arable land of McCracken County amounts to more than 133,500 acres, of which 84,704 acres are improved and cultivated. The average farm, according to the census of 1900, from which these figures are taken, contains 85.7 acres. The tendency is toward a decrease in the size of land holdings, which will be in every way beneficial, as neither the character of the soil nor the labor conditions favor farming on an extensive scale. The percentage of farms operated by the owners is 62.2, and the proportion of farmers owning the land they cultivate seems to be on the increase.

The price of good upland in McCracken County ranges from $20 to $50 an acre, varying with the character of improvements and the distance from the railroads. Remote and unimproved lands are much below these prices. The river lands have greatly enhanced in value within the last few years, but so little changes hands that it is difficult to form a general estimate. Prices range, however, from $25 to $75 an acre, depending upon the amount of clearing and improvements and the liability to overflow. Despite the fact that there is much undeveloped land in the county there is a small but steady flow of emigration, chiefly to the Far West. The loss to the farming population by this cause is counterbalanced by an inflow from Illinois and other Northern States to take advantage of the cheaper lands in McCracken County.

Labor for farm operations is scarce and fairly high priced, owing to the proximity of manufacturing enterprises. Little hired labor is employed during the ordinary farming season, because of the diversity of crops and the distribution of work over a long season. The only season when labor is imperatively demanded is during the cutting and curing of tobacco. The usual price for labor at that time is $1 a day or about $20 a month with board. A large part of the farmers, however, get along by an exchange of labor during the busy season, as their tobacco crops do not reach maturity at the same time. The labor is both white and colored, and is fairly efficient. There is noticeable here, as nearly everywhere in the South, a tendency upon the part of the colored population and of that portion of the white dependent upon day labor to move to the towns where new manufacturing plants and construction work of all kinds offers more remunerative employment and more agreeable surroundings.

The crop of greatest total value grown in the county is corn, which averages nearly 600,000 bushels, and is sufficient to supply the local markets, feed the live stock on the farms, and leave a surplus for shipment. The quality of corn is fair, but more attention should be paid to the breeding and selection of seed corn. The average yield for good and poor seasons and for all types of soil is not far from 25 bushels per acre, but careful farmers may average 35 to 40 bushels per acre.

The crop second in gross value is tobacco. The average acreage devoted to this crop is between 4,500 and 5,000 acres, and the average total yield is not far from 3,000,000 pounds. A large number of farmers have small patches of tobacco, but no one at the present time grows this crop on an extensive scale. Six acres is a good crop for the small farmer, and the average field is less than this. The price received for the product varies widely from year to year, and this is a discouraging feature in the production of an expensive crop. The average price for the tobacco crops, taken as a whole, is from 4 to 5 cents per pound. Crops that have been carefully handled may bring the owner 8 cents, and a fancy lot even more. The tobacco grown is the dark shipping type generally grown throughout northern Tennessee and western Kentucky. The quality favored by the dealer is a heavy oily leaf as thick and strong as can possibly be grown, but free from coarse, hard ribs and fibers, and the color should range from a light to a dark brown.

The production of this type of tobacco involves the constant work and attention of the farmer from early spring to the latter part of October. The seed is sown in beds and the plants are later transplanted in rows. The land must be constantly cultivated during the summer and the plants kept free from worms. In October cutting and curing are well under way. Curing is carried on in barns over open fires. The process requires several days, during which time the heat is at its height for two days and nights. When thoroughly cured the tobacco is usually sold to dealers, who go through the country and negotiate for the crops as a whole. The dealer then has the tobacco graded, packed into hogsheads of 1,000 to 1,200 pounds weight, and hauled to the storage warehouse at Paducah, from which point it is shipped to the manufacturer. The farmer sometimes hauls his tobacco into town and sells it on the street for the best offer he can obtain from the local buyers. Some of these buyers are direct agents for the large manufacturing companies, both foreign and domestic, but a large number are independent speculators. The greater part of the product of this section finds a market in foreign countries, chiefly in Italy. It is used in the manufacture of smoking and plug tobacco and cheap cigars.

In growing a crop like tobacco, when quality determines so largely the value, every effort should be made to improve the character of the product, and to this end the use of good seed can not be too strongly recommended. The seed used in this county is grown by the farmers themselves, and there is naturally some deterioration unless great care is taken. There would no doubt be much benefit derived from the careful breeding of a desired type of plant and from the more careful selection of seed generally.

The yield of wheat in McCracken County is not encouraging and is only barely sufficient to supply local needs. Cowpeas are extensively grown in all parts of the county, and there is a marked increase in the production, as the benefits to be derived from this crop, both as a feed and as a renovator of the soil, become more widely known. It is the almost universal custom to cut the vines about the time the peas mature. The hay is usually baled in the field and, as a rule, enough of the peas are thrashed to supply seed for the next year's sowing. The income from the sale of farm animals and dairy products amounts to considerable. The cows are usually Jersey, mixed with common stock, but there are a few herds of pure Jersey and Holstein cattle. Sheep are not raised in large numbers as formerly, owing to the destruction of the flocks by dogs. Angora goats are kept to a small extent and are said to be more hardy than sheep, not likely to be destroyed by dogs, and are in every way more profitable.

Dairying and truck growing are confined to within a few miles of Paducah, which is the chief market for such produce. Dairying is quite profitable, although the prices for milk and butter are not high. This market is also good for all kinds of vegetables, and many make market gardening a business. There are also quite a number of florists, all of whom have made a success.

Fruits, especially apples, yield well, and, considering the profits, this branch of agriculture has been much neglected. Orchards are not cultivated nor cared for, yet under these unfavorable conditions, considerable money is sometimes realized for the fruit produced. Apples nearly always bring a good price, and often, for good quality of the fruit, reach $1 to $2 a bushel. Such a price would be considered extremely profitable in most apple-growing districts. The crop is reasonably certain in this locality, and it would seem that the growing of apples would be very profitable to some of the farmers who would devote their whole time to the industry. Peaches are more uncertain, owing to late frosts in the spring. Small fruits do well and are grown to some extent for the local market. The pecan does remarkably well, especially on the river soils. There are many wild trees throughout the river land, and they bear heavily nearly every year. The better varieties would no doubt be very profitable.

The uniformity of the upland soils has encouraged a uniform cropping system throughout the county, and but little difference is made in the treatment of the several types of soil. The time land has been in cultivation seemingly has more to do with the productiveness than any noticeable difference in texture. Newly cleared land is considered best for tobacco of the preferred quality, and the land seems to attain its best condition about the third year of cultivation. The bottoms, for reasons dependent upon both soil and flood conditions, have been largely devoted to corn. It is also generally recognized that melons and all vegetables thrive best on the river soil. On the Memphis silt loam the injurious effects of long cultivation of land to one or two crops are generally recognized, and the cultivation of cowpeas is resorted to for the improvement of this unproductive condition. This procedure has proved of marked benefit in most cases and a continuation of the practice and the exercise of care in the succession of crops may in time bring the upland soils to their former condition of productiveness.

McCracken County is well supplied with transportation facilities to distant markets. Four railway lines radiate from Paducah through the county. Three of these are controlled and operated by the Illinois Central Railroad and one by the Nashville, Chattanooga and St. Louis Railway. Besides these lines of travel the city of Paducah is in contact with a long line of navigable water by way of the Tennessee and Ohio rivers, which rivers have their junction at Paducah. It is this situation that gives Paducah its preeminence as a shipping point. The river traffic, while not holding its former position, is still of considerable importance. There are quite a number of regular packets that run to Cairo and to points on the Tennessee and Ohio rivers; also many irregular steamers that move large amounts of freight.

The country roads are far above the average as to condition. The main roads leading out of Paducah are of gravel, and the work of improvement is steadily going on. The gravel roads were formerly toll roads owned by private capital, but now all of them are owned by the county and are free to the public. The cost of improving the roads with gravel, as now practiced by the county, is $400 to $500 a mile.

Paducah, with its population of more than 20,000, affords the only important market for the produce of the county. Tobacco warehouses have been provided for the storage of that product, and buyers are always ready to take corn and other farm produce. The public market at Paducah affords a place for the sale of vegetables and country produce and is well patronized. The city has a large retail trade, and several wholesale houses do a good business.

There are a number of manufacturing enterprises within the area that consume a large quantity of raw material. Saddles and leather goods, barrels, rope, brick, pottery, and furniture are the principal manufactured products.

SOIL SURVEY OF THE CLEVELAND AREA, OHIO.

By **J. E. LAPHAM** and **CHARLES N. MOONEY.**

LOCATION AND BOUNDARIES OF THE AREA.

The Cleveland area covers the Cleveland, Berea, and Euclid quadrangles, for which topographic maps have been made by the U. S. Geological Survey, and includes a land surface of 326,016 acres, or about 510 square miles. The survey includes all but the eastern tier of townships in Cuyahoga County, besides 50 square miles of Lorain County, 29 square miles of Medina County, and 19 square miles of Summit County. The southern and eastern boundary lines of the area are each about 26 miles in length, the western boundary being only about 18 miles long. The whole northern boundary, which is about 30 miles long, is formed by Lake Erie. About 25 square miles of land not devoted to agriculture is covered by the city of Cleveland, which is situated in the north-central part of the area.

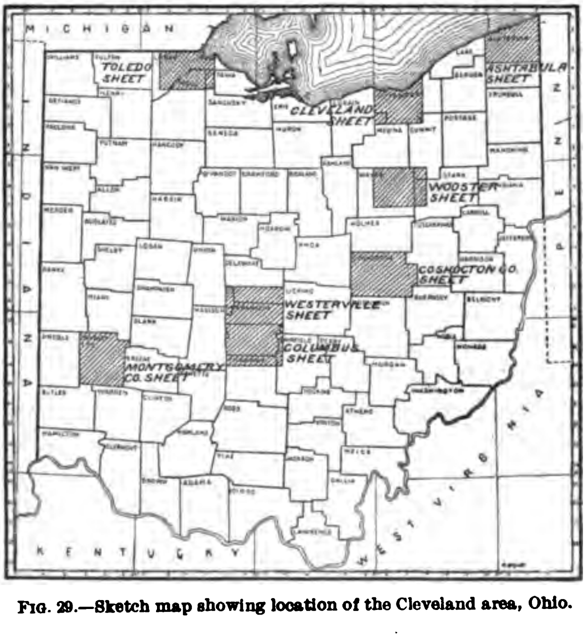

FIG. 29.—Sketch map showing location of the Cleveland area, Ohio.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The Cleveland area is a part of the old Connecticut Western Reserve, lying along the south shore of Lake Erie. In 1795 a resolution was passed by the Connecticut legislature providing for the sale of the lands of this reserve. They were bought by a number of individuals, who formed the Connecticut Land Company and began preparations for the immediate colonization of the lands. In the following year a party under the leadership of Moses Cleaveland was sent to explore and survey the reserve lands. Coming by the way of Lake Erie, they landed at the mouth of the Cuyahoga River and laid out a town on the east bank, naming it Cleveland in honor of their leader. The following spring two families, nine persons in all, established themselves in the new village, and in this year the first crop of corn was grown on a patch of land previously cleared by the Indians. The following year the first crop of wheat was harvested. In 1800 the reserve was made a part of Trumbull County in the Northwest Territory. Following the establishment of a Territorial government and the release by Connecticut to the United States of its jurisdiction over the region, whereby titles to land could be perfected, there was an inrush of settlers, particularly at the close of the war of 1812.

Partly because the location of Cleveland proved unhealthful, and partly because of the water power afforded by the streams, the newcomers and many of the older settlers moved to the uplands, and Newburg, now a suburb of Cleveland, became the principal settlement. But with the increase in commerce and the development of the harbor facilities the lower settlement began to grow more rapidly, until now Cleveland is the largest city in the State.

The pioneer settlers of the Western Reserve were entirely of Connecticut Puritan stock, coming either directly or indirectly from that State, some of them having settled temporarily in New York or Pennsylvania before finally moving westward. These pioneers were a hardy class, well able to withstand the hardships of developing a new country. They were very industrious and practiced the strictest economy. Their living was obtained partly from farming and in part from hunting and trapping. Game was plentiful and formed an important part of their sustenance. Unlike many of the early Western pioneers, they did not make hunting their main occupation, but came to the reserve to till the soil, being attracted by accounts of the great productiveness of the soils of the Ohio country. As the early settlers had a surplus of agricultural products that could be exchanged with the Indians for furs, the fur trade was important for a number of years.

Corn and wheat were the first crops grown and have continued to be the staple crops of the section. A few vegetables were grown for home use. The Indians had cleared small patches of land which they cultivated in a primitive way to corn, beans, pumpkins, squashes, artichokes, and tobacco. The pioneers adopted the growing of tobacco from the Indians, and this crop became a medium of exchange. They also learned from the Indians how to make maple sugar. Maple trees grew abundantly and the production of sugar and sirup increased greatly after markets were obtained, and large quantities are still made in this section. Potatoes were introduced early and became one of the important staple crops. The orchard fruits were also introduced early and succeeded well, but they received little attention and the orchards were allowed to deteriorate. Wild grapes and berries were found in great abundance. The settlers brought some live stock with them, both the horses and cattle being of fair grade.

Because of the lack of transportation facilities and outside markets little progress could be made, and for a number of years prior to 1825 agriculture was at a standstill. It is said that the price of wheat was as low as 25 cents a bushel, potatoes sold for 10 cents a bushel, and other products in proportion. Stacks of wheat were allowed to rot in the fields. What little commerce was carried on in those early days was by pack horses over the old Indian trails. One of these led along the lake shore from Buffalo to Detroit, and another from the Ohio River up the Muskingum River and across the divide to the head of Cuyahoga River, following down that stream to Cleveland, where all the trails converged. In time, however, roads were made and stages passed regularly between the different points.

In 1825 the Erie Canal was opened to traffic, developing the lake-carrying trade, and this was followed by the opening of the Ohio Canal in 1832. It is to these canals that this section owes its earliest development, and they continued of great importance for over thirty years. With the transportation facilities afforded by the canals outside markets could be reached and prices of agricultural products rose, wheat going, it is said, to $1.25 a bushel, and the prices of other products rising in proportion.

In the early forties the building of railroads began, still further increasing the facilities for transportation. Their construction has continued until now several of the main trunk lines of the country pass through Cleveland.

Not only was an impetus given to the production of staple crops, which by 1850 was double that of 1840, but also to a general improvement in agriculture. During this period improved farm machinery was coming into use and attention was being given to the introduction of new and better varieties of field crops and fruits and to the improvement of live stock. During this period, also, some improved varieties of grapes were introduced and succeeded so well along the lake shore that their production has increased greatly. At first they were used entirely for making wine, but in later years they have been marketed largely for table use. Another important industry which developed rapidly was sheep raising. At first attention was given entirely to the production of wool. This was greatest about 1850, when over 200,000 pounds of wool was produced in Cuyahoga County alone. Until 1880 the average was something over 100,000 pounds annually. With the fall in price of wool in the late seventies, and the increasing demand for mutton, the attention of growers was directed to the mutton breeds, with the production of wool as a secondary consideration. In recent years the sheep-raising industry has greatly declined in Cuyahoga County.

With the growth of population in the city of Cleveland came an increased demand for dairy products, and soon the dairy industry became very important. Butter and cheese were made on most of the farms until the establishment of creameries and cheese factories about 1890. The manufacture of butter and cheese has been largely discontinued of late years, owing to the demand for milk.

Market gardening is another important industry that has developed to meet the growing needs of Cleveland's population. The census figures show that in 1840 the value of market-garden products in Cuyahoga County, which then had a population of about 26,000, was a little over $4,000, while in 1900 the value was over $300,000.

PHYSIOGRAPHY AND GEOLOGY.

The surface topography of the area surveyed is somewhat varied, the northwestern and western parts, west of the West Branch of Rocky River, being rather flat and the fall insufficient for good surface drainage. Practically all of the country lying south of a line drawn from Euclid to Berea possesses an undulating or rolling surface, rising from an elevation of about 750 feet above sea level on the upland at Euclid to over 1,250 feet in Royalton Township, Cuyahoga County, and in the northern part of Medina and Summit counties. Noticeable features in the topography are the Lake ridges and the deeply cut ancient valley of the Cuyahoga River. The ridges are three in number and are most prominently developed west of the Cuyahoga River. From the Cuyahoga River to Rocky River their trend is nearly parallel with the Lake, but after crossing Rocky River they take a more southwesterly course, diverging from the present shore line of Lake Erie. These ridges are about 20 feet in height, and slope quite abruptly toward the north, the southern slope being very gentle. They are usually composed of sand or gravel, and represent the coarser materials washed up on an ancient lake shore by the action of the waves.

The valley through which the Cuyahoga River flows is an ancient one, and is remarkable for its depth and width. Well borings made in the bottoms along the present river show that, for a distance of 20 miles up-stream from the lake it was once more than 200 feet deeper than at the present time, and that it was again filled in prior to the establishment of Lake Erie at its present level, and the cutting through of the present stream. No stratified, bedded rocks are to be seen in the valley, both banks having been filled in with drift prior to the recutting of the Cuyahoga and the establishment of its flood plain.

Rocky River, on the other hand, exhibits sharply cut banks through the Erie shale at many points, and is much more narrow and shallow. What is now the East Branch of Rocky River, however, is evidently much more ancient and has performed a work of erosion through the townships of Strongsville and Royalton nearly as great as has the Cuyahoga, the high table-lands on each side rising more than 300 feet above the stream bed. A number of terraces have been built up in the Cuyahoga Valley. These are usually either sandy or gravelly in character, the most noticeable of which is the extensive gravel terrace on the west bank of the river, north of Brecksville. The Cuyahoga and Rocky rivers, with their short, deeply eroded lateral tributaries, constitute the river drainage of the Cleveland area.

The underlying rocks of the area, of the Devonian and Carboniferous systems, are buried beneath a deposit of glacial material or of sediment deposited in Lake Erie when it occupied a higher position than at present. The Erie shale, covered in part by the Dekalb clay, occupies the lowest position in the geological scale, and is the upper member of the Devonian system. Between this and the Berea grit occur the Cleveland and Bedford shales, of somewhat coarser texture than the Erie shale. These are all well exhibited along the banks of Rocky River. The Berea grit is a medium to fine grained sandstone, used extensively for building purposes and for the manufacture of grindstones. Great quantities of this stone are quarried at Berea, on the East Branch of Rocky River, as well as at several other places within the area. Neither it nor the beds of shale between which it occurs seem to exert much influence upon the texture of the soil, except perhaps that the Berea grit is, to some extent, responsible for the coarser texture of the higher lying phase of the Dunkirk loam.

The Cuyahoga shale overlies the Berea grit and separates it from the Carboniferous conglomerate, a sandstone containing in some localities (mainly south of the Cleveland area) a great many quartz pebbles. This sandstone has resisted erosion much better than the Cuyahoga shale, and caps the highest hills of the area, such as the one in the northern part of Brunswick Township, Medina County, the hill in Royalton Township, Cuyahoga County, and the one northeast of Northfield. It outcrops as ledges on some of these hills, and exerts a slight influence upon the soil. It is largely responsible for the area of

Miami stony loam, in Northfield and Bedford townships, and the presence of the sandy material affects to some extent also the texture of the Miami clay loam in Royalton Township, rendering it slightly lighter and more friable.

CLIMATE.

The appended table, showing the mean monthly and anuual temperature and precipitation, was compiled from the records of the Weather Bureau station at Cleveland. These records are the mean of an unbroken period of thirty-three years and should represent fairly the climatic conditions of the area. As will be seen by the table, the mean annual temperature is 49° F. The seasonal means for winter, spring, summer, and fall are, respectively, 28.2°, 46.1°, 69.7°, and 52.3° F.

Normal monthly and annual temperature and precipitation.

Month.	Cleveland.		Month.	Cleveland.	
	Temperature.	Precipitation.		Temperature.	Precipitation.
	°F.	In.		°F.	In.
January	26.6	2.48	August	70.0	2.79
February	27.2	2.81	September	63.9	3.49
March	34.2	2.78	October	52.9	2.71
April	46.1	2.26	November	40.1	2.82
May	58.1	3.36	December	30.8	2.64
June	67.2	3.81			
July	71.9	3.56	Year	49.1	35.51

Lake Erie undoubtedly plays an important part in modifying the climate along its shores. In general the temperature does not rise so high as it does farther inland, nor does it fall so low as it does in the central part of the State. The highest maximum ever recorded was 99° F., and the mean maximum for the year 57° F. Frequently there occur hot, humid spells of short duration, but as a rule the high temperature is offset by the cool breezes from the lake during the heat of the day. The lowest minimum recorded is –17° F., which is about 3° F. higher than for the central part of the State. The mean minimum is 42° F. The extreme range is 116° F.

The mean annual precipitation is 35.51 inches. The seasonal means are, for spring, summer, fall, and winter, respectively, 8.40, 10.16, 9.02, and 7.93 inches. Ordinarily the precipitation is, as shown by the means, well distributed and sufficient to grow all crops, but short spells of drought are common, as also seasons of excessive rainfall. The least rainfall for any year was 24.53 inches, and the greatest 53.51 inches. The average annual snowfall is 42.5 inches.

The dates of the last killing frost in spring and the first in fall during seven years are given in the following table. As deduced from these records the average date of last killing frost in spring is seen to be April 26, and the first in fall October 30. The latest date during this period was May 26, and the earliest October 2. This allows a long enough season safely to grow all farm crops.

Dates of first and last killing frosts.

Year.	Cleveland.		Oberlin.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1897	May 26	Oct. 18	....	Sept. 28
1898	Apr. 5	Oct. 28	Apr. 6	Do.
1899	Apr. 16	Oct. 2	....do...	Sept. 30
1900	May 10	Nov. 9	May 10	Oct. 20
1902	Apr. 15	Nov. 28	May 10	Oct. 10
1903	May 2	Nov. 8	May 2	Oct. 24
1904	Apr. 20	Oct. 24	Apr. 22	Sept. 22
Average	Apr. 26	Oct. 30	Apr. 24	Oct. 6

The mean annual hourly velocity of the wind is 14.6 miles. During the late fall and winter months the prevailing direction is southwest, while during the rest of the year it is southeasterly, except in March and April, when it is west.

SOILS.

Exclusive of Meadow and Muck, eight types of soil are recognized in the Cleveland area. These are adapted to a rather diversified agriculture and range in texture from a gravelly loam to a stiff, waxy clay. There are no coarse sands, however, the sand particles being very fine in the Dunkirk gravelly loam, Dunkirk loam, and Dunkirk fine sandy loam. The different types appear tabulated below in the order of their areal importance:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Miami clay loam	243,456	74.7	Miami stony loam	8,000	2.5
Dunkirk fine sandy loam	27,328	8.4	Dunkirk loam	2,880	.8
Wabash loam	14,080	4.3	Muck	768	.2
Dunkirk clay	10,688	3.3	Meadow	704	.2
Dekalb clay	9,728	3.0	Total	326,016	....
Dunkirk gravelly loam	8,384	2.6			

MIAMI CLAY LOAM.

The soil of the Miami clay loam ranges from 6 to 9 inches in depth and is a silty loam of medium friability. It, however, contains enough clay to cause it to clod when turned by the plow. On many of the fields the clods are reduced with some difficulty. From 5 to 10 per cent of small stone (usually angular) is in some instances scattered about on the surface. The stones are seldom numerous enough to interfere with cultivation and are not often removed from the fields. In a normal state of moisture the color of the soil is a yellowish brown, having a pale grayish cast. When the cultivated fields become thoroughly dried the surface has a yellowish-gray appearance.

The subsoil is a heavy, compact clay loam, the clay content of which below 18 inches is sufficient to make the material smooth and polished when rubbed between the thumb and finger. The color to this depth is usually a pale yellow, in some instances slightly mottled with light gray. The subsoil becomes more compact with increasing depth and the clay content higher, reaching its maximum at 30 inches, where the color is several shades darker—a medium brown. At this lower depth a few shale chips, about one-half inch in diameter, are frequently encountered in boring.

There is some variation in the texture of the soil and subsoil throughout the area, depending upon the topographic and drainage features. Upon the steeper slopes near the streams the texture of the soil and subsoil is occasionally seen to be somewhat coarser, and in some instances a few more stones are present. This is also true upon the upland for a distance of a few rods back from the streams. In the flatter situations and near the boundary line of the Dunkirk clay the soil is somewhat darker and contains more clay and the subsoil is heavier and more mottled.

The Miami clay loam has the widest distribution of any soil type within the area and is found in all parts of the sheet outside of the city of Cleveland.

The surface of the greater proportion of this type is only gently undulating, the drainage channels being quite shallow. Near the main streams, however, the surface features show more relief and the topography is sometimes quite hilly. For the most part the surface drainage is adequate, though, except on the distinctly rolling fields, the best results are only secured by underdrainage. Without artificial assistance an excess of water is retained by the heavy, compact subsoil, rendering the land late and wet.

The Miami clay loam is derived from glacial material which has been transported varying distances and mixed with and modified by the residual matter left behind by the weathering of the native rock.

This type of soil is moderately productive and responds quite readily to proper methods of cultivation and drainage. It is naturally too late for the early market vegetables, but the ordinary farm crops—such as corn, wheat, oats, grass, etc.—do very well. It is a fair apple and pear soil, and though hardly as favorably looked upon for grapes as the Dekalb clay, it is one of the best in the area.

The principal crops grown on the Miami clay loam are corn, oats, and wheat. Corn produces on an average about 30 bushels to the acre; wheat 20 bushels, oats 35 bushels, and hay from 1 to 2 tons. A great many late potatoes are grown upon this type within the area, but produce only a moderate yield. Grape culture receives considerable attention, especially along the lake ridges, a yield of from 2 to 4 tons to the acre being secured.

The following table shows the average results of mechanical analyses of the fine earth of the soil and subsoil of the Miami clay loam:

Mechanical analyses of Miami clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14135, 14139......	Soil.........	1.6	3.1	2.1	7.8	8.8	49.6	26.8
14136, 14140......	Subsoil.....	.8	2.0	1.6	5.7	6.9	42.9	39.5

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 14136, 4.4 per cent.

DUNKIRK FINE SANDY LOAM.

The Dunkirk fine sandy loam to a depth of 10 or 12 inches consists of a brown or reddish-brown sandy loam, which is quite fine in texture. The soil is generally very loose and mellow and is easily worked. No clods form to interfere with the maintenance of good tilth. There is seldom any stone at the surface, though along the crests of some of the lake ridges in the northwestern part of the area some small gravel is mixed with the soil and subsoil. This occurs where the band of gravelly material is too narrow to indicate upon the map as a separate soil type.

The subsoil is a yellow sandy loam, generally considerably heavier in texture than the overlying soil. Occasionally thin streaks and lenses of light-colored clay are found, but as a rule the clay is evenly distributed among the grains of fine sand, resulting in a plastic and sometimes sticky sandy loam, uniformly colored and without mottling. Except in the situations mentioned above there is no gravel or stone in the subsoil.

The Dunkirk fine sandy loam is confined to the northern part of the area, occurring along the North and Middle ridges and on the delta upon which the city of Cleveland is built.

On the lake ridges the type is usually found as a long, narrow strip, parallel with the escarpment, and extending back about a quarter of a mile from the crest onto the higher terrace. The topography here is either uniformly sloping, as along the face of the escarpment, or gently rolling, as on the upper terrace. East of the Cuyahoga River the surface is for the most part quite flat, though slightly undulating along some of the small streams.

Wherever the surface is undulating the subsoil is naturally loose and porous enough to make the drainage of the type usually adequate without resorting to much tiling or ditching.

The Dunkirk fine sandy loam is formed through the agency of wave and stream action and is the weathered product of the coarser sediments deposited in lakes, rivers, deltas, etc.

The Dunkirk fine sandy loam is the best adapted to general trucking and market gardening of any of the soils in the area. Its relatively free drainage and porous structure make it a warm soil which does not contain much water in excess of crop needs. It is the most desirable soil for the earlier vegetables, such as peas, sweet corn, early potatoes, cucumbers, asparagus, strawberries, etc. Though this type of soil is used to a considerable extent for general farm crops, a very large acreage is devoted to the growing of small fruits and vegetables for the local market.

The following table shows the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Dunkirk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14121, 14123......	Soil.........	0.7	2.7	3.7	39.5	32.4	11.2	9.2
14122, 14124......	Subsoil.....	.1	1.0	1.0	40.8	35.1	12.5	9.2

DUNKIRK GRAVELLY LOAM.

The soil of the Dunkirk gravelly loam averages about 10 inches in depth and is a dark-brown loam containing silt and the different grades of sand in varying proportions. In many instances it is much more sandy than silty in character, a condition which is frequently found along the ancient lake ridges. From 20 to 50 per cent of small gravel, up to one-half inch in diameter, is scattered over the surface. This gravel consists, for the most part, of flat pieces of shale which have been partially rounded by the action of water.

The subsoil is a light-brown or yellowish loam, generally of about the same texture as the soil, though in some instances more sandy, especially below 30 inches. The content and distribution of gravel is similar to that in the soil. Borings were not made below 36 inches, but several bank sections were seen, showing the gravel to extend to depths ranging from 4 to 20 feet or more.

The principal areas of the Dunkirk gravelly loam are found in the northern and northwestern parts of the survey, though it is well developed also in the central part in terraces along the Cuyahoga River. These terraces are usually very flat topped, with rather steep slopes down to the streams. Along the lake ridges the front of the escarpment, while quite sloping, is always gentle enough to allow cultivation, while the top of the ridge has usually a slight fall back toward the south. Only upon the broader, flatter terraces is the natural surface drainage insufficient to take care of the ordinary rainfall. The presence of the gravel generally secures fair underdrainage, though ditching is sometimes of advantage in the flatter situations.

The Dunkirk gravelly loam is, in the case of the lake ridges, the weathered product of material washed up along the shore line of Lake Erie when it occupied higher levels than at present. The terraces in the Cuyahoga Valley and along the smaller streams are also of ancient formation, having been derived from the gravel and other material brought down by the streams and deposited as deltas.

In favorable topographic situations, and where not too freely drained and droughty, it is one of the best soils in the area for fruit. With the exception of the Dunkirk fine sandy loam it is the best type for general market gardening and is also an excellent soil for corn and potatoes. The type as a whole is devoted to general agriculture, though in locations nearest to the city the greater proportion of the acreage is used for vegetables, including nearly every variety which can be brought to maturity in this climate.

The following table shows the average results of mechanical analyses of the fine earth of the soil and subsoil of the Dunkirk gravelly loam:

Mechanical analyses of Dunkirk gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14117, 14119	Soil	5.5	9.1	2.9	6.1	8.6	46.5	21.2
14118, 14120	Subsoil	4.7	9.4	3.1	6.5	9.0	46.2	20.8

DUNKIRK CLAY.

The Dunkirk clay, to an average depth of about 9 inches, consists of a dark-gray or drab heavy clay loam or clay. Slight mottling is frequently noticed. The clay content is so high that the soil usually cracks at the surface and, when cultivated, shows a tendency to break into small angular and more or less cubical lumps. There is seldom any stone or gravel present either in the soil or subsoil.

The subsoil is a drab heavy, sticky clay, which is mottled with light gray and with brown iron stains. This brown staining is not infrequently accompanied by the presence of a few minute iron concretions, giving a slightly granular texture to the material.

The greater proportion of the Dunkirk clay is found in the edge of Lorain County, in the northwestern corner of the survey. Smaller areas of it are to be seen irregularly distributed in other parts of the survey, generally in depressions along drainage channels.

The surface of this type is uniformly low and flat, and the natural drainage is never sufficient rapidly to dispose of surplus rain waters. A very thorough and expensive system of ditching and tiling is necessary to fit this type of land for agriculture, and even under the best of conditions obtainable many of the fields are late and wet in the spring.

The soil is the weathered product of the finer sediments of the glacial débris, deposited in somewhat basinlike depressions, where the conditions of drainage were deficient.

When well drained and properly cultivated, the Dunkirk clay is a fair soil for grass and grain and the heavier farm crops. With the exception of some of the later and heavier types of vegetables, such as cabbages, it is not well adapted to gardening. It is principally used for the ordinary crops, and produces, under favorable conditions of climate and cultivation, an average of about 30 bushels of corn, 25 bushels of wheat, and about 1½ tons of hay to the acre.

The following table shows the average results of mechanical analyses of the soil and subsoil of the Dunkirk clay:

Mechanical analyses of Dunkirk clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13360, 14113......	Soil.........	0.4	2.0	1.5	5.0	4.2	35.7	50.7
13361, 14114......	Subsoil.....	.3	1.1	1.1	4.1	4.8	31.0	57.4

MIAMI STONY LOAM.

The soil of the Miami stony loam averages about 9 inches in depth, and is a light-brown loam containing considerable silt, together with an appreciable quantity of very fine sand. The texture is, as a rule, noticeably coarser than that of the Miami clay loam, resulting in a more mellow, easily tilled soil. From 10 to 40 per cent of stone, for the most part angular pieces of fine-grained sandstone, are scattered about over the surface of the fields and mixed with the subsoil. The subsoil is a yellow loam, with some lack of uniformity in its texture. In some localities it is decidedly silty. In others, where the sandstone formation, known as the Berea grit, is near the surface, it contains considerable fine sand. The sand not infrequently occurs in small pockets, resulting from the breaking down, in place, of the friable, easily disintegrated fragments of sandstone, which form in some instances from 20 to 50 per cent of the whole mass. The stone strewing the surface and distributed through the subsoil, in parts of the area where the Berea grit does not reach the surface, consists generally of angular and subangular fragments of shale and of rounded, glacially transported bowlders of crystalline rock.

The Miami stony loam is found distributed in all parts of the area. The largest continuous body is located northeast of Northfield. Another occurs about 4 miles northwest of Olmsted Falls. The topogaphy of most of the areas, with the exception of the one last named, which is rather flat, is quite sloping. Some of the areas occur in the vicinity of well-defined benches, where the overcapping ledges of sandstone terminate rather abruptly upon the underlying shale. Examples of this are to be seen northeast of Berea, and again in the long, narrow areas passing through Independence. The drainage of this type is fairly adequate, owing to the rolling topography and to the physical assistance of the rock fragments in the subsoil.

The Miami stony loam is a glacially transported soil and its origin is similar to that of the Miami clay loam, its coarser texture being due to the sandy material received from the disintegration of fragments of sandstone of the Berea grit or Carboniferous conglomerate. The rounded crystalline stones, granite, gneiss, etc., have traveled with the glacier many hundred miles from the north.

The Miami stony loam is adapted to the needs of a fairly diversified agriculture, and can be used for most of the ordinary farm crops. It is a somewhat earlier soil than the Miami clay loam, and, the stones seldom being numerous enough to interfere with cultivation, the soil remains in better tilth with less labor and weeds are more easily controlled. About the same class of crops are grown upon this type as upon the Miami clay loam, and, so far as could be observed, the yields do not differ materially.

The following table shows the average results of mechanical analyses of the fine earth of the soil and subsoil of the Miami stony loam:

Mechanical analyses of Miami stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14131, 14133......	Soil.........	1.0	3.7	3.0	13.2	13.2	45.4	19.6
14132, 14134......	Subsoil.....	1.6	4.5	3.3	14.4	11.5	36.9	27.4

DUNKIRK LOAM.

The Dunkirk loam is characterized by a brown loam soil extending to a depth of 8 to 10 inches. While the soil consists mainly of silt, with some clay, it contains enough sand to make it appear somewhat like a sandy loam. It is somewhat more granular than the Miami clay loam, and contains more clay than the Miami stony loam. The subsoil is a yellow and brown mottled heavy loam or sandy clay. The sand and clay material of the subsoil is not intimately and uniformly mixed, but appears somewhat in the form of pockets and lenses. In some localities, however, over an area of several acres, borings will show a subsoil distinctly more sandy than the greater portion of the type. Though there is scarcely ever any stone found at the surface, there are occasionally a few fragments of sandstone in the subsoil, but these are not sufficiently numerous to influence the character of the underdrainage.

Local areas occur, principally as long, narrow strips along the lake ridges, in which the color of the soil and subsoil is considerably darker, while the texture is slightly heavier. This condition usually occurs in depressions where there is deficient drainage and a greater accumulation of organic matter.

The greater part of the Dunkirk loam lies along the East and West branches of Rocky River, in the western half of the sheet, together with an area in Brooklyn Township, and one on a terrace of the Cuyahoga River near its confluence with Tinkers Creek.

With the exception of the narrow areas mentioned above as occurring in depressions along the Lake ridges, the type occupies level or gently undulating positions, usually adjacent to streams, so that drainage can be secured at a reasonable expense. Without artificial drainage some of the areas of this type are exceedingly difficult to manage, the sandy clay subsoil retaining an excess of water to a greater extent even than the apparently heavier subsoil of the Miami clay loam.

The Dunkirk loam is formed from the glacial materials brought down from the north, largely modified by the sandy material derived from the weathering of the sandstone formation, which is usually in close proximity to this type. The depressed areas of dark-colored soil in the vicinity of the Lake ridges are due in large part to the wash received from the more elevated soils surrounding them, which are usually of a sandy nature.

When sufficient drainage has been secured the higher lying phase of the type should make one of the best soils in the area for potatoes, and it is also fairly well suited to late vegetables and to the general farm crops, especially corn and oats. The general use to which it is applied is for the ordinary farm crops, and the yields secured average about the same as upon the other heavier upland types of soil.

The following table shows the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Dunkirk loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13695, 14115......	Soil.........	1.4	6.7	5.1	16.6	9.8	38.1	22.1
13696, 14116......	Subsoil.....	2.4	8.3	6.5	17.4	10.2	32.5	22.5

DEKALB CLAY.

The soil of the Dekalb clay averages about 6 inches in depth and consists of a pale-yellow or grayish-yellow heavy clay loam or clay, which cracks at the surface when left long uncultivated and which clods when turned by the plow. Small, thin chips of shale, an inch or less in diameter, are often scattered over the surface. In many instances the soil has a very high clay content, as shown by the manner in which it polishes when rubbed between the thumb and finger.

The subsoil is generally a uniformly colored yellow clay, showing little mottling. The clay is extremely heavy, though it is rather dry and brittle than unctuous. In some localities the underlying shale rock is encountered at less than 3 feet from the surface, and in these situations there is sometimes a small percentage of fine shale chips mixed with the subsoil. There are seldom any large fragments of shale in either soil or subsoil.

The Dekalb clay is confined to the northern bench or terrace adjoining Lake Erie and occurs in a strip varying from one-quarter to over a mile in width, trending in a direction parallel with the lake shore. It is well developed west of Dover Bay, at Lakewood, and north and northeast of Nottingham. It occupies a position for the most part level, though in a few localities, along the small streams which intersect it, it is seen to be slightly rolling. Natural drainage is never adequate, owing to the densely heavy subsoil, and a generous system of tiling or ditching is necessary to carry away surplus water.

The Dekalb clay appears to be more nearly a residual soil than any other type in the area, and probably owes its origin principally to the degradation of the fine-grained Erie shale through wave action of Lake Erie at a time when the lake occupied a higher level than at present, the material being transformed into a soil by the agencies of atmospheric weathering.

This type of soil is in especial favor for grape culture, and though it is generally thought to be a relatively unproductive soil for grains, grass, and the cereals, it is said by the growers to do well in vineyards. It is a soil, however, which requires special care in the matter of drainage and cultivation, as it is naturally intractable and droughty. Quite a large number of vineyards are situated upon it, the yields averaging about 2 or 2½ tons to the acre. The Concord is the variety usually grown, though some Delawares and Niagaras are also produced. Besides grapes the type is used for pasturage and for the ordinary farm crops, the yields being usually below those for the Miami clay loam.

The following table shows the average results of mechanical analyses of the fine earth of the soil and subsoil of the Dekalb clay:

Mechanical analyses of Dekalb clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13343, 14111......	Soil.........	2.2	3.8	1.5	3.5	3.4	37.2	48.2
13344, 14112......	Subsoil.....	1.2	2.3	1.0	2.2	3.5	28.9	60.5

WABASH LOAM.

The Wabash loam is generally a brown loam possessing a soft, loose, silty texture. In some instances there is no essential change in character of the material down to the maximum depth of the borings—36 inches. Usually, however, the line between the soil and subsoil occurs at about 12 inches. The subsoil is a brownish-yellow silty loam, containing considerable clay, but noticeably less compact than the subsoil of the Miami clay loam. It is not often that there is any stone present in either the soil or subsoil.

Some variation exists in the characteristics of this type. Sometimes both soil and subsoil are lighter in color than in the case of the greater proportion of the type, and the subsoil, particularly, is heavier in texture and oftentimes exhibits a greasy consistency.

The principal areas of the Wabash loam occur along the Cuyahoga and Rocky rivers. It is also found bordering the majority of the smaller streams of the area. The type is almost wholly flat, rarely being relieved by the undulating or terraced topography not infrequently seen in the stream bottoms in many sections of the country. Artificial drainage is required to carry off the excess of water, especially in the spring, during high water in the adjacent streams and when some of the bottoms themselves are frequently inundated.

The Wabash loam is an alluvial type of soil and is formed by deposits of fine earth washed from the upland, carried down by the streams, and built up along their banks in times of freshet.

Well-drained areas of this type are very well suited to corn and are also desirable for many of the garden vegetables. Selected areas from the sandy phases fulfill the general requirements of a potato soil, and profitable returns ought to be secured. It is, however, in general use for the ordinary farm crops, but more particularly for corn, which, under favorable conditions, produces from 40 to 60 or more bushels per acre. Upon some of the sandier phases of the type, situated at convenient distances from the city, a little market gardening is carried on.

The following table shows the average results of mechanical analyses of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Wabash loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14127, 14129......	Soil.........	0.1	0.5	0.6	5.2	10.5	62.3	20.2
14128, 14130......	Subsoil.....	.1	.6	.6	13.5	21.1	49.7	13.6

MUCK.

The Muck mapped in the area consists of a black soil containing a large amount of vegetable matter and having a light, loose, mealy texture. It varies considerably in depth, ranging from 6 inches to 2 feet or more. The subsoil, if any is present in the conventional 36 inches to which the soils are examined, is generally a heavy drab or blue silt and clay.

Areas of this type occur southwest of Northfield, northeast of Berea, and northeast of North Olmsted. It occupies flat, marshy depressions in the upland, and a complete system of drainage is necessary to bring it under cultivation.

Muck owes its origin to the incorporation with the mineral material of a great quantity of organic matter, in the absence of drainage and under conditions which favored an excessive growth of swamp vegetation.

This soil is very useful and desirable for the growth of such crops as onions and celery. It is also a very fair corn soil, and often good potato crops are grown upon it. It is generally used, however, for corn and for pasturage. From 30 to 50 bushels of corn per acre are usually produced.

MEADOW

The term Meadow applies to certain areas having no definite arrangement of soil particles, and covered with a rank growth of marsh vegetation, occurring along some of the smaller streams and in depressions where there is little or no drainage. The surface of these areas is frequently boggy, and they have no present agricultural value other than the limited amount of pasturage which they furnish. The largest extent of Meadow occurs southeast of Northfield. These areas are capable of reclamation, and when thoroughly drained will produce many of the farm crops which do not require too early spring cultivation.

AGRICULTURAL CONDITIONS.

The farming land in the Cleveland area is under a high state of cultivation, and is devoted to a diversified agriculture. That part of the area which is in close proximity to the city is especially valuable, because of the desirability of the land for market-gardening and for building lots. The farms are, for the most part, equipped with good buildings, both barns and dwelling houses, and the grounds surrounding the dwellings are in many instances as well kept and trimmed as those around the city homes. The farmers enjoy a fair degree of prosperity, and there is comparatively little indebtedness among them. They employ up-to-date methods, and the majority of them know how to make agriculture pay. The prices for land for fruit and vegetable growing range from $150 to $800 or more per acre, depending upon nearness to the city and the texture and drainage of the soil, as well as upon the climatic conditions. Farms on the Miami clay loam bring, for general agricultural purposes, from $50 to $100 or more per acre, according to geographic location, buildings, etc.

According to the census of 1900, 67 per cent of the farms are worked by their owners, while four-fifths of those operated under the tenant system are on a cash rental basis, the rate ranging from $3 to $8 or more per acre. Many of the farms of this class are used for market gardening, and the leases are often for long terms of years. Only about 4 per cent of all the farms of the area are rented on shares.

While the average size of the farms in Cuyahoga County, as given by the Twelfth Census, is 52 acres, there are over 500 farms containing more than 100 acres each. Many of the small 10 to 20 acre farms are owned by foreign-born citizens, principally Poles and Bohemians. They are a thrifty class, good gardeners, and utilize every square foot of the land in a most thorough manner.

The farm labor of the area is very largely employed by the day, from $1 to $2, according to supply and demand, being paid. Much of the day labor is drawn from the foreign population of Cleveland and the small towns, and is fairly abundant, especially for work that can be conveniently reached by the various lines of suburban electric cars. The laborers hired by the month, most of whom are of American parentage, usually receive from $18 to $25, with board. In 1899 there was expended for labor in Cuyahoga County $407,810, or an average of about $90 for each farm.

Corn, wheat, oats, and grass are the common field crops grown in the area. The acreage given to grass, for hay and pasturage, is much greater than to any other crop, oats, according to the statistics of 1900, holding second place. Hay brings a good price and finds a ready market in the city and is a profitable crop to grow. Dairying is one of the most important industries in the area, over 5,000,000 gallons of milk having been supplied to Cleveland in 1899. Ensilage forms one of the principal items in the feed of the cattle during the winter, so that a considerable percentage of the corn is cut green for this purpose. The power harvester and shredder are in common use. Quite a large acreage within the area is devoted to potatoes, and in years of favorable seasons and prices the industry is profitable. During the present season (1905) there has been considerable complaint of the potato blight, and the yield is below the average, probably under 50 bushels to the acre. The late varieties are usually the ones grown. The large demands of the city of Cleveland for fresh vegetables has resulted in the establishment in the immediate territory surrounding the city of an important market-gardening industry, and all of the fruits and vegetables that can be grown in the latitude of northern Ohio are produced with profit. A variety of soils is found along the old Lake ridges, and the length of the growing season is somewhat extended by the tempering influence of the lake. The same advantages of soil and climate are largely responsible for the concentration along the most northern lake ridges of extensive and profitable vineyards. Some of the grapes are made into wine, but the greater proportion is marketed in baskets. The total value of the product of the vineyards in Cuyahoga County in 1899 was $255,306, while, for the same year, the value of orchard products, apples, cherries, peaches, plums, pears, etc., was $162,462.

The farmers of the area show an intelligent understanding of the adaptation of soils to crops, and wherever circumstances permit they select such soils as best suit the requirements of the crops to be grown. The greater proportion of the early vegetables are grown upon the lighter soils of the old lake ridges, while the heavy Dekalb clay, which has proven well adapted to grape culture, is, to a large extent, devoted to that crop. Many vineyards are also to be seen upon the Miami clay loam. The greater proportion of the Wabash loam is used for corn, which produces more abundantly upon this than upon any other type in the area.

The Cleveland area enjoys excellent transportation facilities. The Nickel Plate Railroad parallels the Lake Erie shore throughout the area, a distance of about 30 miles, while the Lake Shore and Michigan Southern Railway has about an equal mileage, diverging from the Nickel Plate Railroad at Cleveland in a southwestern direction. Both of these roads run into Chicago, and make direct connections with New York, giving splendid facilities for both passengers and freight. The Big Four Route connects Cleveland with Columbus, Cincinnati, and St. Louis, while the Pennsylvania Railroad, the Wheeling and Lake Erie, the Erie Railroad, and two branches of the Baltimore and Ohio Railroad give service in southerly and southeasterly directions. Besides the steam roads, five suburban electric lines run into and through

Cleveland and carry express and freight as well as passengers. Daily boats ply between Cleveland and Buffalo, Toledo, Detroit, and other lake ports during all but the winter months. Much has been done toward the establishing of good public roads radiating from Cleveland in different directions through the area, and many miles of brick and macadamized roads have already been constructed. Much yet remains to be desired in the building of the country dirt roads, and it is believed that if the supervision of their location, grading, and drainage were intrusted to an expert in road building both economy and convenience would result.

An excellent market for the farm and garden produce of the area is afforded by Cleveland and the small suburban towns. Cleveland at present numbers nearly half a million population, and its growth from year to year is steady and substantial. Its market needs offer every incentive for the highest development of market gardening, dairying, and general agriculture.

SOIL SURVEY OF THE WESTERVILLE AREA, OHIO.

By J. E. LAPHAM and CHARLES N. MOONEY.

LOCATION AND BOUNDARIES OF THE AREA.

The Westerville area is situated in the south-central part of the State of Ohio, and comprises about 475 square miles. It includes all of the Westerville and Dublin quadrangles of the United States Geological Survey, which lie between 82° 45′ and 83° 15′ west longitude, and 40° and 40° 15′ north latitude. No definite civil boundaries are followed, but the area includes the northern half of Franklin County, together with a narrow strip along the western edge of Licking County, the larger parts of the townships of Mill Creek and Jerome in Union County, about 12 square miles of Madison County, and a belt about 3 miles wide along the southern boundary of Delaware County. The area takes in a part of the northern edge of the city of Columbus, which is located midway of the southern boundary. Columbus is in the same longitude as Detroit, and the same latitude as Philadelphia.

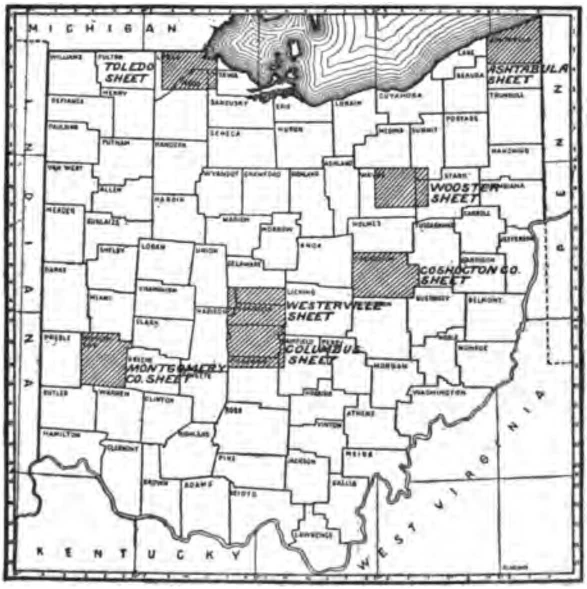

FIG. 30.—Sketch map showing location of the Westerville area, Ohio.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

It was not until after the close of the Revolutionary war that the first permanent white settlements were established in the section of the State covered by the present survey. Franklinton, on the site of the present city of Columbus, was laid out in 1797 by Lucas Sullivant, who came from Virginia to survey the lands known as the Virginia Military District, and to be used for the benefit of the soldiers from that State who fought in the war of the Revolution. Following the settlement at Franklinton were others scattered along Alum Creek and the other water courses of Franklin and the adjoining counties, wherever the most desirable farming lands were located. Wheat, which was cut with a sickle and thrashed with a flail, was one of the principal crops grown by the early settlers. For several years there was no mill or settlement nearer than Chillicothe, and much difficulty was experienced in getting the wheat ground into flour. The first small mill in Franklin County was built about 1799 a short distance above Franklinton. The first store was built in Franklinton about a year after settlement began, but for several years Chillicothe, 45 miles south, on the Scioto River, was the town to which the pioneers journeyed to secure their merchandise and get their mail.

Franklin County was organized in 1803, from Ross County, and Delaware was erected from Franklin in 1808. The first settlement in Delaware County was made in 1801, 5 miles below where the town of Delaware now stands. The early settlers of Delaware, as well as of Franklin County, came principally from Pennsylvania, New York, and Virginia, and from Massachusetts and the other New England States.

Lack of transportation was a great bar to progress during the early history of the section. The country being heavily forested, the roads were few and in bad condition, and as much as possible of the travel was made by boat on the rivers. In 1825 the National road, which Congress had ordered constructed from Cumberland Gap to the Ohio River, reached the latter point, and in 1836 it was constructed through Columbus in the direction of Indianapolis. In 1825 the Ohio Canal, which was to connect Cleveland with Portsmouth on the Ohio River, was commenced. The Columbus feeder tapped the canal at Lockburn in the southern part of Franklin County in 1831, and the main canal was finished in 1838. The first railroad was begun in Ohio in 1841, and in 1850 the first passenger train ran into Columbus on the Columbus and Xenia Railroad.

Considerable interest was early manifested in the establishment of agricultural societies and fairs, and in the improvement of cattle and other live stock. By act of the legislature, 1828, an agricultural convention was authorized to be held annually in Columbus, at which all of the counties of the State were to be represented.

CLIMATE.

The appended table gives the mean monthly and annual temperature and precipitation for the station of the Weather Bureau at Columbus. While there are several voluntary observation stations within the area and around it and records have been kept for a number of years, the data are in all cases incomplete. The records given are for a period of twenty-six years. They are continuous and complete, and should fairly well represent the conditions obtaining in the area. The mean annual temperature, as shown by the table, is 52.2° F. The seasonal means for winter, spring, summer, and fall are, respectively, 30.7°, 51°, 73°, and 54.2° F. The average maximum temperature for the summer season is 83.2° F. Hot spells are of common occurrence, during which the temperature sometimes reaches 90° F. or more. These periods of extreme heat are generally accompanied by a high relative humidity and often by hot nights. The winter weather is quite variable. The average minimum temperature is 23.7° F., though a temperature as low as −20° has been recorded in both January and February. The average snowfall for the past twenty-six years is 23.5 inches.

The average date of the first killing frost in autumn is October 16 and of the last killing frost in spring April 16. The rainfall is usually well distributed throughout the year, the least fall occurring in the autumn and winter months. The seasonal averages for spring, summer, autumn, and winter are, respectively, 10, 10.20, 8.07, and 8.99 inches. The prevailing direction of the winds throughout the year is generally southwesterly, though in February and March they are westerly and in September southerly.

Normal monthly and annual temperature and precipitation.

Month.	Temperature.	Precipitation.
	°F.	*Inches.*
January	28.8	3.04
February	30.8	3.25
March	39.0	3.28
April	51.4	2.89
May	62.6	3.83
June	71.2	3.55
July	75.3	3.59
August	72.6	3.06
September	66.5	2.54
October	54.6	2.33
November	41.6	3.20
December	32.6	2.70
Year	52.2	37.26

PHYSIOGRAPHY AND GEOLOGY.

The Westerville area consists of a comparatively level plain having a slight fall to the south. The maximum elevation of 1,140 feet above sea level is reached in the southeast corner of Delaware County, on the eastern edge of the map, while the least elevation is found 17 miles farther southwest, where the Olentangy River flows from the area. Into this plain four principal valleys have been eroded by the Scioto and Olentangy rivers and by Alum and Big Walnut creeks, which are crossed in the order mentioned in traveling through the area from west to east. These streams take nearly straight, almost parallel, and approximately equidistant courses a little east of south, flowing from the northern to the southern boundary of the area. The higher intervening uplands average about 4½ miles in width, and from their crests to the streams the topography shows a gentle slope at the rate of about 100 feet to the mile, the relative depths of the valleys ranging from 100 to 200 feet. The immediate escarpment or stream bank is apt to be quite abrupt, ranging in height from 15 to 30 feet or more above the bottoms. Along the streams varying widths of alluvial flats have formed, the most extensive ones being seen along Alum and Big Walnut creeks. The Scioto River flows through a narrow, gorgelike valley and little alluvium has been deposited along it. Shorter, lateral streams, tributary to the four main ones, have eroded small valleys into the upland, and where these join the main streams their banks are sometimes quite high and steep. A narrow strip of bottom land sometimes fringes their lower courses.

The greater portion of the upland plains is only gently undulating. In Harlem Township, Delaware County, in the northeastern corner of the area, the fall is seen to be in some places less than 20 feet to the mile; and, also, in the southwestern part of the area the surface appears quite flat to the eye, and only a very slight fall is shown by the topographic contour lines. With the exception of these two localities, however, the fall is sufficient to secure easy drainage, and the surface is undulating enough to afford pleasing relief to the eye.

The natural forest growth has been largely cut away so that for the most part only small, sparsely timbered wood lots are at present to be seen. Probably not over 10 per cent of the area is forested. The original growth on the Miami clay loam upland consisted largely of the various oaks, beech, and hard and soft maple, while the swamp white oak, hickory, and black walnut were the predominating species on the lower lying Miami black clay loam and the bottom lands. In the last few years considerable interest has been manifested by some of the farmers in the planting of trees for post timber and other uses, the common locust and catalpa being the species selected for this purpose.

The underlying rock structure of the Westerville area consists of limestones and shales of the Devonian and Carboniferous ages. Belonging to the former division are the Corniferous limestone and the Huron shales, while the Carboniferous age is represented in the area by the Waverly group. The Corniferous limestone is found in the western part of the area, mainly west of the Scioto River. This limestone is hard and offered much resistance to preglacial erosive agencies, so that lateral stream drainage tributary to the Scioto is not as well established as in some other parts of the area. This formation, with the possible exception of a very narrow strip on the east bank of the Scioto, has been covered with glacial material and the prevailing type of soil, the Miami clay loam, shows no recognizable difference in character from that covering the central and eastern parts of the area surveyed. The rock is not exposed except along the Scioto River, where it is quite extensively quarried for building purposes.

The Huron shales, the next highest in the geological scale, cover the greater portion of the area, extending in a broad belt from north to south. These blue shales constitute much the most easily eroded rocks of the area, and the cutting of the streams has resulted in producing a rougher, more undulating topography, especially near the edge of the escarpment, where the short lateral water courses join the main streams.

The rocks of the Waverly group are confined to the eastern and northeastern parts of the area. They consist of shales and a fine sandstone, in the latter of which a quarry has been opened at Sunbury. These rocks, like those of the underlying Huron shales, are covered with a blanket of glacial drift and enter into the composition of the soils only so far as their residual material has been mixed and ground up and left in an altered state by the passage of the glaciers. The Miami clay loam is here as elsewhere the principal type.

SOILS.

The soil conditions of the Westerville area are quite uniform, and only four distinct types have been recognized.

The following table gives the relative and actual extent of each of these types:

Areas of different soils.

Soil.	Acres.	Per cent.
Miami clay loam	267,264	87.8
Miami loam	17,856	5.9
Miami black clay loam	16,128	5.3
Miami gravelly loam	3,136	1.0
Total	304,384	

MIAMI CLAY LOAM.

The soil of the Miami clay loam, to an average depth of 10 inches, possesses a fine uniform silty texture, exhibiting little variation in the most widely separated parts of the area. Though the soil contains a relatively high percentage of clay, the particles are so masked by the silt that the clayey characteristics of a sample as a whole are not noticeable when in a normal state of moisture. There are sometimes present a few granules of shale or limestone of the size of coarse sand or fine gravel, giving to the mass a very slightly gritty feel. These can oftentimes be broken down between the thumb and finger. Very little stone occurs in the soil or subsoil of this type, except along the escarpments bordering nearly all the streams and bottom lands. In these situations the glacial gravel is exposed, and a band of from 2 to 10 rods wide of more or less gravelly soil results. Where this is of sufficient width to indicate on the map, it appears as Miami gravelly loam. The surface color varies from a light yellowish brown, in locations where natural drainage is the best, to a dark brown, in areas of slight depression and at the line of contact with Miami black clay loam. The texture of the soil in the latter instances is somewhat heavier, the subsoil remaining about the same.

The subsoil is a compact silty clay, slightly mottled with dark-brown or bluish clay in some instances, but the color is usually a uniform brownish yellow. The subsoil becomes gradually heavier with increasing depth, and a few chips of shale or limestone are sometimes encountered. Except along the streams, as mentioned above, there is but little stone or gravel in the subsoil, until the glacial till or bowlder clay is reached at a depth of from 4 to 6 feet.

Miami clay loam is the predominating type in point of distribution, and is found in all parts of the area surveyed, forming 87.8 per cent of the entire area of the sheet. The topography varies somewhat. Along the principal streams there is often quite an abrupt fall of from 20 to 50 feet from the uplands down to the bottoms, the escarpment line being more or less dissected by small lateral streams. Upon the upland, from 2 to 5 miles back from the main streams, the surface is slightly undulating. The natural drainage in the latter situations is usually deficient, and to improve this condition a great many miles of open ditches and tile drains have been put in. Even those portions of the type where a fairly undulating surface prevails require a more thorough drainage than they generally receive.

The Miami clay loam is derived from a combination of the residual material, caused by the weathering of the underlying rock, and the various assortment of materials subsequently brought down and distributed by the glaciers. In this work the glaciers were assisted by a considerable volume of water from the melting ice.

The Miami clay loam is essentially a grain and hay soil, and is well adapted to general farming purposes. Of the grain crops, wheat and oats do best. Hardly as good results are secured with corn as upon the Miami loam and the best drained areas of Miami black clay loam, but it is nevertheless a very good corn soil in seasons of normal rainfall and under intelligent methods of cultivation. Under good methods of cropping and cultivation wheat will yield on an average from 20 to 25 bushels and corn from 40 to 50 bushels per acre. Hay produces 1 to 2 tons, the product being timothy and clover, separate or mixed. A small proportion of the home vegetables produced in the area is grown upon this type.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Miami clay loam:

Mechanical analyses of Miami clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
12820, 13213, 13215, 13217, 13219..	Soil	0.8	2.4	1.8	5.4	7.5	58.6	21.2
12821, 13214, 13216, 13218, 13220..	Subsoil.....	.7	2.5	1.8	6.0	7.6	44.0	36.9

In order to ascertain the manurial requirements of this soil a large sample was collected 1 mile west of Dublin. The soil here is a light-brown silty loam of uniform texture, the sample being taken to a depth of about 7 inches. The history of the particular field from which the sample was taken was not obtained, but the larger part of the area of the Miami clay loam has been in cultivation for fifty years or more, receiving occasional small applications of stable manure.

Results obtained by the wire-basket method indicate that a good increase in productiveness may be obtained by an application of cowpeas and lime; that an application of nitrate of soda and acid phosphate will give a moderate increase; and that a very small increase may be obtained by use of manure, of acid phosphate, of lime, or of potash, or by a combination of these.

In these tests wheat plants were used as an indicator and the results are held to be applicable only to related crops and to the particular field from which the sample was taken.

MIAMI BLACK CLAY LOAM.

The surface 12 inches of the Miami black clay loam consists of a dark-brown to nearly black fine-grained loam, composed mainly of silt, but containing enough clay to render it quite sticky when wet, and to cause it to form wide and deep cracks at the surface when it is allowed to dry without cultivation after a rain. If plowed or cultivated when wet, clods form to a considerable extent, though upon contraction some of these latter show a tendency to slake and break down into small angular and more or less cubical granules, forming a sort of mulch at the surface. A small amount of sand of the finer grades occurs in the soil, but its presence is scarcely discernable to the touch or to the unaided eye. Rarely is any stone or gravel seen at the surface or in the subsoil of the Miami black clay loam. Cultivated under the proper conditions of moisture, the soil works up loose and mellow and forms an excellent seed bed.

The subsoil consists of a heavy, sticky, waxy clay, so close and compact in structure as to offer great resistance to the passage of water. The clay content usually increases with depth, though in some cases the subsoil is seen to grow somewhat lighter and more silty just below 30 inches. The color of the upper section of the subsoil is a very dark drab, slightly mottled with brown. Below 18 to 24 inches the color is usually a slightly mottled brownish yellow.

The Miami black clay loam is found most extensively developed in the southwestern part of the area, though it is sparingly distributed in other parts. In the vicinity and west of Hayden and Kileville occur some quite large and connected areas. In the eastern and central parts of the area there are to be seen many small and irregularly shaped areas from one-half acre to 2 or 3 acres in extent, occurring in depressions in the Miami clay loam. Though these are quite noticeable in driving over the roads and are of importance in the relation of the adaptation of soils to crops on individual farms, the scale of the map (1 inch to 1 mile) did not admit of their being separately shown, and it was necessary to omit many of these smaller areas from the map. In the case of the larger areas of Miami black clay loam in the western part of the survey it was impossible to recognize many of the clay knolls (Miami clay loam) which occur scattered about in otherwise uniform areas of the black clay loam.

The Miami black clay loam is nearly always found in flat or more or less basinlike areas. Narrow strips also occur along some of the smaller drainage ways, especially at their upper ends. Because of their relative nearness to natural outlets and the oftentimes greater fall, these latter-mentioned strips are the most easily drained of any of the areas of Miami black clay loam. The larger more continuous bodies of the type, found at some distance from natural drainage outlets, require considerable outlay to fit them for the production of cultivated crops.

The Miami black clay loam was formed after the retreat of the glaciers in the areas of depression and poor drainage. These wet spots favored the growth of a great deal of vegetation, the decay and subsequent incorporation of which with the mineral matter is responsible for the resulting black soil.

Well-drained areas of Miami black clay loam are especially well adapted to corn. The subsoil is usually abundantly supplied with moisture for the needs of the crop, and if worked at the right time and under favorable conditions cultivation is not difficult. The land needs to be very thoroughly underdrained and the water table lowered. Wheat gives good yields in favorable seasons, but one year with another it is best confined to the Miami clay loam. If the ground is first thoroughly drained, potatoes would do well upon this type, as also some varieties of vegetables, such as celery, onions, cabbage, etc.

At present corn, wheat, and oats are the principal crops grown upon the Miami black clay loam, the former having the largest acreage, and yielding from 40 to 75 bushels under average conditions. Wheat produces about 25 bushels in good years, while about 50 bushels of oats per acre are secured. Grass is usually grown in rotation with corn and wheat, and yields on an average about 1½ tons. A great many of the kitchen gardens of the area are situated upon the Miami black clay loam. It is noticeable that in areas of Miami clay loam the dwelling houses will frequently be located near a spot of the black clay loam of half an acre or so in extent, suitable for the home garden.

The following table shows the average results of mechanical analyses of the soil and subsoil of the Miami black clay loam:

Mechanical analyses of Miami black clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13209, 13211	Soil	0.8	2.1	2.1	7.0	7.2	51.9	28.6
13210, 13212	Subsoil	.5	2.0	1.5	4.5	7.9	50.3	33.1

In order to ascertain the manurial requirements of this soil a large sample was collected 2½ miles southeast of New California. The sample was taken to a depth of 8 inches, the soil at this point being a black clay loam which clods badly. The field from which the sample was taken has been in cultivation for probably more than forty years, has been poorly handled, and has received no fertilizer, except small quantities of stable manure. It has been planted to corn, oats, and grass, but the yields have been below the average for this type of soil.

Results obtained by the wire-basket method indicate that only a moderate increase in productiveness can be obtained by the application of manure, and only a very small increase by the use of lime or any form of mineral fertilizers. They furthermore seem to indicate from the excellent growth obtained in the untreated soil that improved mechanical condition of the soil by cultivation will prove more beneficial than the addition of fertilizers.

In this test the soil was placed in ideal physical condition and a favorable water content was maintained during the growth of plants. Wheat was used as the test crop, and while the results are held to be applicable only to the field from which the sample was taken and to general farm crops, it seems probable that they will apply in a general way to the greater part of this type of soil in the area.

MIAMI GRAVELLY LOAM.

The soil of the Miami gravelly loam, to a depth of about 10 inches, is a reddish-brown loam, containing from 10 to 30 per cent of medium-sized gravel, which has a tendency to give good tilth. The subsoil consists of a heavy clay loam or clay, containing from 20 to 50 per cent of mingled gravel, shale, and limestone chips, rendering the boring below 24 inches very difficult. The gravel seldom exceeds 3 inches in diameter, while the greater proportion of it is much smaller.

With the exception of a few isolated areas in the eastern and southeastern parts of the sheet, the Miami gravelly loam is found only along the Scioto and Olentangy rivers and Alum and Big Walnut creeks, in the southern extension of their courses through the area. In the latter location the type occurs upon the forelands and second bottoms, immediately along the streams and areas of Miami loam or bottom lands. On the forelands the topography is quite apt to be abrupt, the angle in some cases being prejudicial to cultivation, and the height of the face of the escarpment ranging from 10 to 30 or more feet. The type sometimes occurs in the river bottoms, as a second terrace, or as a low ridge in the Miami loam. In these instances the topography is much smoother, and the terraces usually flat topped. Near the eastern limit of the area occur a few glacial hills, rising from 15 to 40 feet above the level of the surrounding plain. These are in some cases gravelly enough to be classed with the gravelly loam type; in other cases, however, the areas are too small, or the gravel is not sufficiently abundant. By reason of its favorable topographic position and the relative high porosity caused by the contained gravel, the Miami gravelly loam is nearly always adequately drained.

The Miami gravelly loam has been derived from the coarser materials carried by the glaciers, their arrangement being modified to a greater or less extent along the streams by the action of water.

The second bottom phase of this type is admirably adapted to corn, wherever the drainage is not so free as to make the soil too droughty. Alfalfa should also do well in these positions, and the stony slopes might with advantage be utilized for grapes and other fruit. At present the Miami gravelly loam areas are devoted to the ordinary farm crops, corn, wheat, oats, hay, and to some extent, vegetables. The yields secured upon the sloping forelands, where there is too free drainage, are from 10 to 30 per cent less than upon the upland Miami clay loam. On the second bottoms, however, the yields are very good, 50 bushels of corn to the acre being frequently secured. Wheat and oats produce well, and good returns are obtained from grass crops.

The following table shows the average results of mechanical analyses of the fine earth of soil and subsoil of the Miami gravelly loam:

Mechanical analyses of Miami gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13205, 13207.......	Soil	3.7	8.9	4.2	6.3	5.5	38.2	32.7
13206, 13208.......	Subsoil.....	5.4	11.5	4.8	5.5	4.2	24.5	43.8

MIAMI LOAM.

To the depth of 10 or 12 inches the soil of the Miami loam is a dark-brown mellow loam, comparatively easy to cultivate. A very slight amount of fine sand is sometimes present, but not in sufficient quantities materially to affect its loamy characteristics. While the soil has somewhat the appearance and color of the Miami black clay loam, it is lighter in texture, more tractable and easily cultivated, and not so much inclined to form clods. The subsoil consists of a heavy clay loam, ranging in color from a dark brown mottled with drab to a light brown or brownish yellow at the lower depths. Gravel often underlies this type at 3½ to 5 feet, but is seldom encountered in the 3-foot borings.

The Miami loam is found along all of the larger and most of the smaller streams of the area. Its best development is seen along Alum and Big Walnut creeks, where it averages nearly half a mile in width. It also occurs along Olentangy River, though the Scioto Valley, within the area, is deeply cut and narrow and little of the Miami loam has formed along it. The type usually occupies flat first bottoms though in some cases it occurs as slightly undulating and terraced second bottoms. In the latter position the surface drainage is more favorable and inundation is less likely to occur. Most of the first bottoms are overflowed annually, and sometimes oftener. Diking is sometimes resorted to at the bends of the streams to overcome this condition as much as possible and to prevent destructive washing of the fields by swift currents. While the underlying gravel is a natural aid to the drainage of the type, extensive systems of ditching and tiling are necessary in some localities to secure the best results.

The Miami loam has been formed by the deposition of sediments washed down from the uplands, and carried down by the streams during high water. This sedimentation has been going on ever since the emergence of the land from the sea and is still in progress.

Areas of the Miami loam upon the lower first bottoms should be devoted to such crops as can be matured after the subsidence of the spring floods. Upon such fields it is not safe to sow winter wheat or to try to grow alfalfa, which will not long endure submergence. On the second bottoms alfalfa and clover do well, and the soil is also especially well adapted to corn. Some of the heavier garden vegetables are profitably grown upon this type.

The type as a whole is devoted chiefly to corn, which yields from 50 to 80 bushels to the acre. Clover produces from 1 to 2 tons, and is an important crop. Alfalfa has not come into general favor, though a few small fields have been successful. Wheat yields from 20 to 30 bushels to the acre upon the second bottom phase of the type. It is less frequently grown upon the first bottom, owing to the danger of destructive flooding.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Miami loam:

Mechanical analyses of Miami loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13201, 13203	Soil	0.3	1.1	0.9	2.5	3.5	51.3	39.9
13202, 13204	Subsoil.....	.8	2.6	1.7	3.5	3.0	39.3	48.8

In order to ascertain the manurial requirements of this soil a large sample was collected from a field 1 mile west of Worthington. The sample was taken to a depth of 8 inches, and is a brown, mellow, silty loam, easily cultivated.

The field from which the sample was taken is bottom land. It has been in cultivation for many years, producing large yields of corn, the average at present being over 60 bushels per acre. No stable manure has been used, but small applications of acid phosphate have been applied with wheat, the average yield of this crop being good.

Results obtained by the wire-basket method indicate that a marked increase in productiveness may be obtained by an application of stable manure; that a small increase may be obtained by the use of cowpeas and lime, but that only a very small increase may be obtained by the use of lime alone or by the use of any form of mineral fertilizer.

In these tests wheat plants were used as an indicator and the results are held to be applicable only to related crops and to the particular field from which the sample was taken. To what extent they are applicable to other crops is a subject for further investigation.

AGRICULTURAL METHODS.

The agricultural methods of the area do not differ in any important respect from those in use in other sections where farming operations are confined principally to dairying and the growing of grain. The sulky plow is used only to a very limited extent, the common walking plow, cutting both a wide and deep furrow, and drawn by two or three horses, being generally employed. For crushing the refractory clods of the Miami clay loam and the Miami black clay loam both the land roller and "rubber" are used. The latter is made by fastening three or four 2-inch planks together and lapping them in such a way that their sharp corners project and crush and smooth the clods rather than compact them as the implement is drawn over the surface. Many of the farmers consider this a more efficacious implement than the roller for smoothing irregularities in the surface and crushing the clods. After rolling or smoothing the land sometimes requires to be gone over two or three times with the harrow before it is sufficiently well pulverized to form a proper seed bed and to prevent undue evaporation of the soil moisture beneath.

In the operation of haying all of the most modern labor-saving appliances are brought into use, such as hay tedders, improved hayrakes, loaders, and stackers. The greater proportion of the corn is cut by hand, though machine binders are in use where the crop is gathered for ensilage. Small grain is, of course, all harvested with the self-binder.

The practice of crop rotation is quite general, consisting usually of corn followed by wheat or some small grain; then grass, which is allowed to occupy the ground for one or two years; followed by corn again. The barnyard manure produced is usually thoroughly utilized, and comparatively little commercial fertilizer finds its way upon the lands of the area.

AGRICULTURAL CONDITIONS.

The farms of the Westerville area are, with few exceptions, moderately well drained, intelligently cultivated, and equipped with buildings suitable to their needs. A great many of the dwellings are commodious, possess neatly painted, attractive exteriors, and are surrounded by large, well-shaded, and well-tended grounds. There is comparatively little indebtedness among the farmers of the area, and many of them, by the exercise of good business judgment, the adoption of up-to-date methods, and careful attention to details, are able to accumulate something each year above their living expenses. Many of them have telephones in their houses, some have natural gas for heating, lighting, and cooking, and others are fortunate enough to have an electric suburban car line pass their doors. The whole area is served by the rural free postal-delivery system, thus enabling the busy farmer to receive his daily paper and mail without the necessity of going to town for it. Educational advantages are excellent. The common schools are well conducted and well patronized, and the opportunities for a college or university training are afforded both within the area and in the nearby towns of the State.

According to the census of 1900, a little over half of the farms of the area were operated by their owners, while about 30 per cent were worked by the tenant system. Of the latter class of farmers a little over half, or 17 per cent of all in the area, were paying a cash rental ranging from $3 to $5 an acre. The share tenants usually furnish stock and tools and receive one-half the crop.

While there are a number of farms in the area, especially in the western part, containing above 150 acres each, the average size is about 85 to 90 acres. Of the total area, from 85 to 90 per cent is under cultivation, the remainder being woodland and such waste land as occurs in steep-sided ravines and gullies and along some of the streams.

The farmers of the area complain considerably of the difficulty in securing labor. Farm hands are scarce and demand moderately high wages, the maximum being about $22 a month, including board, and, in some instances, the maintenance of a horse. These farm hands are all white, and the most of them are intelligent, efficient, and industrious workers, and the wages do not seem out of proportion to their services.

The principal products of the area are hay, corn, and small grain. Although considerable wheat is still grown, generally in rotation with corn and grass, its production is gradually being abandoned, owing to low prices and the close competition of the Western States. The census for 1900 shows that in 1899 a little less than 60,000 acres were sown to wheat in Franklin County, while according to figures prepared by State officials the acreage in 1905 is only a little over 29,000 acres. There has also been a decrease of over 27,000 acres in the planting of corn during the same period of time. This decrease is partially balanced by a 26 per cent increase in the production of oats, by the increased acreage of rye, and by grass sown both for hay and pasturage. The appreciation of the manurial value of clover is increasing, and the acreage of it and other leguminous plants, grown as soiling crops, is being extended. Several thousand acres of grass are grown in the area for pasturage, and in 1904, according to State agricultural statistics, there were sold in Franklin County nearly 3,000,000 gallons of milk. Over 750,000 pounds of butter were produced by the farmers, while the factories in Franklin County made 111,330 pounds more. There are several creameries and skimming stations within the area. The cattle, as well as other live stock of the area, including horses, hogs, and sheep, number among them thoroughbreds and grades of the standard breeds, and in general are very well suited to the requirements.

The greater proportion of the fruit grown in the area is for home consumption, and, with the exception of apples, none of the varieties attain a yield of commercial importance. The cultivation of vegetables for profit receives little attention, except in the vicinity of Columbus, where some of the later, heavier varieties are successfully grown. The best-drained portions of the Miami loam are fairly well adapted to this profitable industry.

There are no special evidences of recognition of the adaptation of soils to crops, except perhaps that the Miami black clay loam is generally more exclusively devoted to corn than to other crops, though wheat, oats, and grasses are also quite extensively grown upon the same type. The production of corn also receives special attention upon the areas of Miami loam.

Columbus is an important railroad center, and numerous lines radiate thence in all directions, giving quick transportation and the best of service for both passengers and freight to St. Louis, Cincinnati, and the South; Indianapolis, Chicago, Detroit, Cleveland, Pittsburg, Norfolk, and New York and the East. Besides these well-equipped steam roads the area is served by four suburban electric lines passing directly through it, together with several more which operate in a southerly direction out of Columbus. These all carry freight and express as well as passengers, and are of distinct benefit to the farming sections through which they pass. A very creditable system of country roads and turnpikes is maintained in the area. Nearly all of the main thoroughfares are surfaced with stone, the quite common custom being to build up the stone-surfaced driveway wide enough for one track upon one side of the road, leaving the other with the natural dirt surface for travel in dry weather.

Columbus, with a population approaching 150,000 people, affords an excellent market for all kinds of farm produce. Other important markets are Cleveland, distant 139 miles; Cincinnati, 125 miles; Chicago, 314 miles; and Pittsburg, 193 miles. It will thus be seen that a wide range in the choice of markets and transportation lines is offered the producers of the Westerville area.

SOIL SURVEY OF THE OXFORD AREA, MICHIGAN.

By GROVE B. JONES and M. EARL CARR.

LOCATION AND BOUNDARIES OF THE AREA.

The Oxford area is situated in the southeastern part of lower Michigan and comprises the six northeastern townships of Oakland County. It embraces an area of 134,144 acres or about 210 square miles, and constitutes a northward extension of the soil survey made in Oakland County in 1903, which covered the nine southeastern townships of the county.[a] The area is bounded on the north by Lapeer County and on the east by Macomb County.

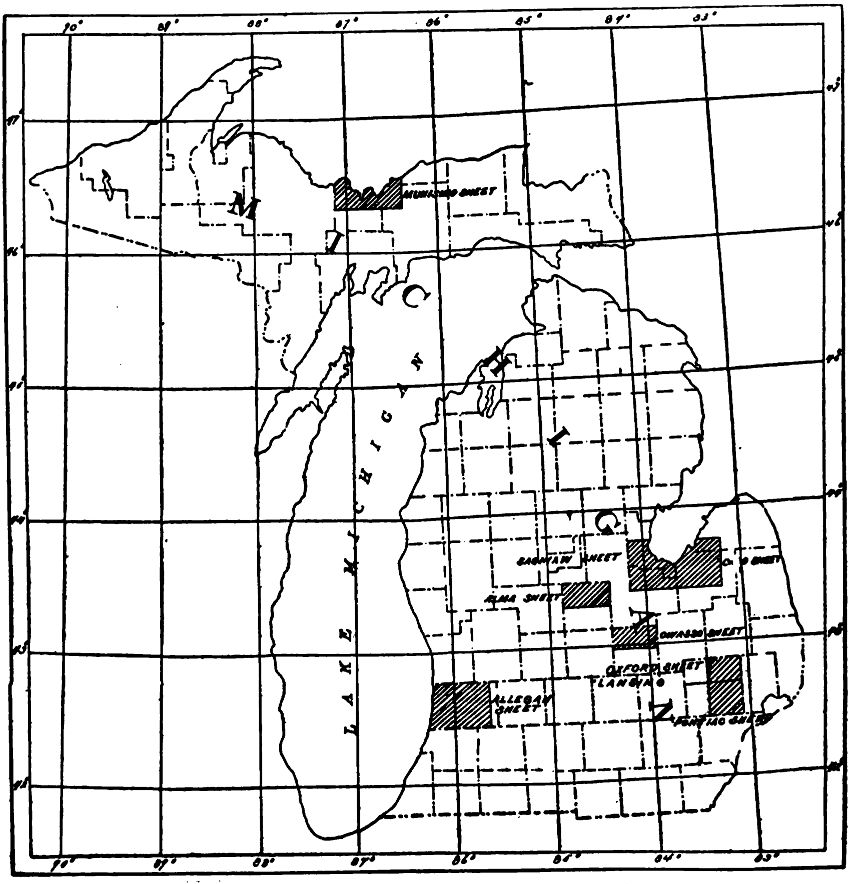

FIG. 31.—Sketch map showing location of the Oxford area, Michigan.

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[a] Soil Survey of the Pontiac area, Michigan. Field Operations of the Bureau of Soils, 1903.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Until about 1815 all of this part of Michigan was an unbroken wilderness occupied only by Indians. In the next few succeeding years scattered settlements were made throughout the region, and in 1819 a county government was organized, the first in the interior of the State. The population at this time was small and scattered. The Indians still occupied much of the country, but were not troublesome, and gradually disappeared before the advancing tide of civilization.

A large proportion of the pioneer settlers of the county, as well as of the State, came from New York, as is evidenced by the names of many of the towns and villages, the settlers giving them the names of their former home towns. Other settlers came from the New England States, New Jersey, and Pennsylvania, and a few direct from European countries.

The county was surveyed and plotted on the section plan, each section being 1 mile square. The land was sold by the Federal Government at a low price, thus inducing immigration to this section, notwithstanding the fact that it took about thirty days to make the journey from New England and New York.

The increase in population for a time was not especially rapid, but was steady. In 1825 the population of the county was 1,362, but during the next decade it reached 7,390, and for thirty-five years thereafter the rate of increase was more than 1,000 a year. According to the census of 1900, the population of the county was 44,792, which, however, when compared with that of 1870, shows an increase of only 3,925. The slight increase in the last three decades is explained by the fact that during a portion of that time there was an exodus to the newer States of the West and Northwest.

The early settlers found nearly all of the land covered with a dense forest, and as the timber at that time had no commercial value it entailed a vast amount of labor without any immediate remuneration to clear and prepare the land for cultivation.

The first crops grown were almost, if not entirely, for home use, but with the increasing acreage of wheat and corn the production soon exceeded home demands and the surplus was transported by water and marketed in the East.

The acreage of wheat exceeded that of all other crops for a long time, but for many years it has been growing less and less as the adaptability of the sandy soils to other crops has been recognized. At present the principal crops of the county are potatoes, beans, corn, hay, and fruits.

In some localities stock raising has gained considerable prominence, and it is in these communities that the best farms of the county are to be seen.

CLIMATE.

The following climatological data, compiled from the records of the Weather Bureau stations located at Birmingham and Flint, show the normal monthly and annual temperature and precipitation for this section. Birmingham is 11 miles south of the southern boundary of the area, while Flint is 19 miles north of the northern line:

Normal monthly and annual temperature and precipitation.

Month.	Birmingham		Flint.		Month.	Birmingham.		Flint.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°*F.*	*In.*	°*F.*	*In.*		°*F.*	*In.*	°*F.*	*In.*
January	23.0	1.75	22.2	1.54	August	68.2	2.38	67.4	2.65
February	22.7	1.97	20.9	1.50	September	61.4	2.53	61.2	2.69
March	31.7	2.13	30.6	1.71	October	50.0	2.43	49.1	1.97
April	46.3	2.51	45.2	2.31	November	36.9	2.82	35.8	2.55
May	59.5	3.22	56.2	3.67	December	26.5	1.82	26.6	1.76
June	68.2	3.23	65.9	3.03	Year	47.2	29.59	46.0	28.22
July	72.0	2.80	70.1	2.84					

The following table shows the dates of the first and last killing frosts as recorded at the same Weather Bureau stations:

Dates of first and last killing frosts.

Year.	Birmingham.		Flint.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1901	Apr. 22	Oct. 4	Apr. 21	Oct. 4
1902	May 11	Oct. 8	May 15	Oct. 10
1903	May 4	Oct. 23	May 4	Sept. 29
1904	May 11	Oct. 7	May 11	Sept. 21
Average	May 5	Oct. 12	May 6	Oct. 1

PHYSIOGRAPHY AND GEOLOGY.

The topography of the area surveyed is rolling to hilly, with comparatively little level country. It is considerably more rolling and hilly than the Pontiac area and is the roughest section of the county. Its elevation is slightly higher than the Pontiac area, and it lies on the crest of a watershed which extends southwestward across the State from the point of " the thumb " at Port Austin and separates the Saginaw Basin from the Lake St. Clair Basin. The greater part of the area lies to the southeast of this watershed and its drainage is accomplished by small streams flowing southeasterly into Lake St. Clair and the Detroit River. Only a small proportion of the area, in the northern and northwestern parts, is drained by streams of the Saginaw Basin.

As a result of the rough topography the heavy soils found in the Pontiac area occur here to a much less extent, the sand and sandy-loam types predominating. The most level section of the area occurs in a more or less broken body extending westward from about 2½ miles east of Oxford to the western boundary of Oxford Township, and thence southwest to the southern boundary of the area. Although there is very little level land, practically all of the rolling, hilly country can be cultivated. The surface of the whole area is typical of a glaciated region. This is especially noticeable in the numerous lakes, which vary in size from a few square rods to nearly a square mile. The largest lakes are Lakeville, Orion, Long, Whipple, Voorheis, and Deers. Lakes are most numerous in the more level section above mentioned and form one of the most prominent physiographic features of the area. Large and small basinlike depressions of muck and " tamarack swamps " are also of frequent occurrence, marking an advanced stage of the more shallow glacial lakes.

The surface of the whole county is covered by a mantle of glacial drift, burying the native rocks so deep that they do not enter into or influence the soil formations. This drift occurs both as a land and water deposit. Numerous land moraines occur, which were deposited during some temporary halt of the ice front in its recession northward at the close of the glacial period. Other parts of the area seem to have been formed by shallow water deposits or swift currents emerging from the ice sheet. Frequently sections of both the level and rolling lands show stratified and cross-bedded sands and gravels, indicating currents of water of varying velocities not flowing for any great length of time in the same direction during deposition. Again, other sections show a disorderly mass of drift without any arrangement whatever. Almost always the surface to a depth of 3 to 5 or more feet consists of unsorted drift, even where it overlies the stratified material. Large bowlders of granite and other crystalline and metamorphic rocks occur on the surface in some portions of the area. Most of the bowlders, however, are of moderate size and are generously distributed over the entire area.

SOILS.

Ten different soil types, including Muck and Meadow, were mapped in this area. These several types do not occur in extensive areas, but are found in small isolated bodies, the light and heavy soils being closely associated without any uniformity as to occurrence. Bodies of Muck occur in all the different types.

The extent of each of the soil types mapped is shown in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Miami fine sandy loam	44,224	32.9	Meadow	4,992	3.7
Miami sandy loam	35,584	26.5	Miami gravelly sand	3,968	3.0
Muck	15,424	11.5	Clyde fine sandy loam	1,600	1.2
Miami clay loam	12,160	9.1	Miami black clay loam	1,216	.9
Miami gravelly sandy loam	9,472	7.1	Total	134,144	
Miami sand	5,504	4.1			

MIAMI GRAVELLY SANDY LOAM.[a]

The soil of Miami gravelly sandy loam to a depth of 12 inches is a brown sandy gravelly loam. The coarser grades of gravel predominate, the gravel representing from 25 to 70 per cent of the soil mass. The subsoil is a brown medium to coarse sandy loam containing varying quantities of gravel. Sometimes the subsoil is a loose gravel bed, the layer of sandy loam being entirely lacking.

The surface in some sections is covered with well-rounded stones and pebbles up to 8 inches in diameter. While the surface is often uneven and stony, there is but a small percentage of this soil that can not be cultivated. The rougher part of this type lies in the southeastern corners of the area. In the latter place a very desirable quality of gravel is secured for railroad ballast, while any of the smaller knolls scattered throughout this type afford good material for road use.

With the exception of the area in the northern part of Independence township, embraced mainly within sections 3 and 4, the Miami gravelly sandy loam occupies some of the roughest and most hilly parts of the area surveyed. Isolated areas occur as knolls and ridges among other types, and usually contain a higher percentage of coarse gravel than the less rolling areas of the type. The level area in Independence Township, above referred to, is thickly strewn with the coarser grades of gravel and pebbles. The larger pebbles and bowlders have been removed from the surface of much of this type of soil and are either used in making fences or are piled in the fields.

The Miami gravelly sandy loam is a glacial soil, part of which is morainic in origin. Its physiographic position and structure render it a naturally well-drained soil. The area immediately north of Oxford is only moderately rolling, and upon it general farming is practiced. In favorable seasons good crops are produced. Corn yields about 50 bushels, potatoes from 125 to 200 bushels, hay about 1½ tons, and rutabagas from 400 to 700 bushels per acre. The Miami gravelly sandy loam is a desirable soil for peaches, apples, grapes, small fruits, and vegetables.

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[a] In the adjoining area of Pontiac this type was called Allegan gravelly loam.

The following table gives the average results of mechanical analyses of the fine earth of this soil type:

Mechanical analyses of Miami gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14259, 14261	Soil	6.1	16.7	12.2	28.4	11.8	16.4	7.8
14260, 14262	Subsoil	4.6	19.1	12.6	24.1	9.1	11.8	18.9

MIAMI SAND.

The Miami sand is a light to dark brown medium to fine sand from 6 to 15 inches deep, underlain by a yellow or reddish-brown medium to fine sand to a depth of 3 feet or more. Small areas of fine gravel frequently occur in this type of soil, but areas of coarse gravel with occasional bowlders are not often found. With the exception of small knolls, the soil generally contains sufficient organic matter to give it a loamy texture. The degree of loaminess is greatly influenced by the cultural methods employed.

The Miami sand occurs both as small level areas and as isolated knolls. For the most part it is well drained, the exceptions being the margins where it borders bodies of Muck. In such cases the top soil is a dark-brown or black sand, while the subsoil is usually a light-gray color.

About the same crops are grown upon the Miami sand as upon the heavier soils of the area, but the yields are usually light. Some few fields, however, were noticed where, by the introduction of better cultural methods, the productiveness of the soil had been greatly increased, in one instance being five times as great as that of an adjoining neglected field.

The Miami sand readily responds to fertilizers, and by careful management can be made a productive, profitable, and lasting soil. It is well adapted to vegetables and fruits and any crop requiring a light sandy soil. Potatoes do especially well in wet seasons, but when the rainfall is below the average they are apt to suffer from drought.

Field peas sown in June and cut before maturity, but after they are well podded, produce excellent roughage and greatly increase the productiveness of the soil. Twelve quarts of corn added to one bushel of field peas, which is sufficient to sow one acre, also makes a good crop for feed.

The following table gives the average results of mechanical analyses of the fine earth of this soil type:

Mechanical analyses of Miami sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13375, 14257	Soil	0.3	4.4	9.6	53.6	19.3	8.1	4.4
13376, 14258	Subsoil	.2	2.9	8.2	57.6	21.3	6.3	3.1

MUCK.

The Muck areas of this survey consist of accumulations of organic matter of different degrees of decomposition. The less decomposed material more nearly resembles Peat, but it was impossible to separate this material from the true Muck. This accumulation of vegetable remains is underlain by clay, sand, and marl, and upon the character of the subsoil depends the value of these Muck areas. Muck underlain by clay is considered a valuable soil, if so situated that it can be artificially drained. Abundant yields of hay, corn, and vegetables are produced. Where the subsoil is a sand and the Muck covering is less than 2 feet deep it is practically worthless, except for grazing purposes. When dry this Muck or Peat will burn readily, and when the vegetable matter is thus removed the underlying sand is unfit for agricultural purposes.

The largest areas of Muck occur mostly in the western half of the survey, but isolated patches and areas, in which small streams have their source, occur in nearly all parts of the survey. The natural growth consists of water-loving grasses and tamarack, while upon the more shallow clay subsoil areas oak, elm, and other hardwoods occur.

A few small areas of Muck are being cultivated, while others have been cleared or burned over and sufficiently drained to be used for pasturage. Corn, onions, carrots, potatoes, and celery produce abundantly. For the growing of onions the Muck is plowed in the fall about 8 inches deep, and from April 20 to May 10 the onions are planted. The average yield is about 700 bushels per acre. Sugar beets grow luxuriantly, but have a high content of impurities.

The Muck is best adapted to celery. Many of the areas could be drained at a moderate cost, and considering the abundant yields to be had from the growing of special crops it is surprising that more of such areas are not drained and put in a cultivable condition.

MEADOW.

The term Meadow, as used in the Oxford area, includes the low-lying wet land adjacent to streams and a few isolated swampy areas in the upland. The soil is of a variable character, ranging from clay loam to gravel. The areas are not suitable for cultivation, but usually support sufficient grass for pasturage. The timber growth consists of oak, elm, hickory, and other hardwoods. The largest area of Meadow is about 5 miles east of Clarkston, midway between Orion and Independence townships. This area supports a heavy timber growth.

MIAMI BLACK CLAY LOAM.

The soil of the Miami black clay loam, to a depth from 8 to 15 inches, is a black or drab-colored clay loam. The subsoil is a drab-colored clay, more compact and tenacious than the soil. Its naturally wet condition renders this soil practically unsuited for cultivation without artificial drainage. The soil is heavy and plastic, and if worked when too wet forms clods and bakes. Near the boundaries between the Miami black clay loam areas and the areas of sandy soils there is usually a thin veneer of sand, which, when mingled with the clay loam, renders the soil more friable, easier to work, and less liable to crack and bake.

As it occurs in this area the Miami black clay loam is of little importance. It embraces but few square miles, is usually not yet sufficiently drained for cultivation, and is devoted principally to grass.

The largest body of the Miami black clay loam occurs in Oxford Township, and embraces parts of sections 17, 18, and 19. Large ditches have been dug through this area, but at present only the higher and better-drained portions are cultivated. A few small areas are scattered through the northern part of the survey, while patches too small to map frequently occur as depressions in the Miami clay loam type.

The level surface and wet condition of this soil account for its texture and color. Where drained and cultivated corn is the principal crop grown and yields as high as 75 bushels per acre, the average being about 50 bushels. For hay the average yield is 2 tons per acre.

The following table gives the results of mechanical analyses of samples of this soil type:

Mechanical analyses of Miami black clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14273	Soil	0.4	2.4	2.3	11.9	10.0	47.8	24.8
14274	Subsoil	.4	1.2	1.7	9.3	11.5	49.2	26.4

MIAMI GRAVELLY SAND.[a]

The soil of the Miami gravelly sand consists of a brown gravelly sand from 8 to 12 inches deep. There is present in varying amounts fine gravel and coarse sand, with sometimes enough fine material to render the surface loamy. Occasionally the underlying gravel outcrops upon the surface. The subsoil is a coarse yellow sand, containing fine gravel in slightly greater quantities than the soil.

The Miami gravelly sand occupies high ridges and knolls, which fact, together with its loose porous structure, renders it very susceptible to drought. The largest single area of the type occurs east of Ortonville, where it occupies a series of well-rounded knolls, presenting a rough, billowy topography. In this particular area the Miami gravelly sand is closely associated with the Miami sand. Frequently the side of one hill will be typical Miami sand, while on the opposite side the Miami gravelly sand will be typically developed. Pockets of pure sand also occur.

On account of its physiographic position and its susceptibility to drought, but few attempts have been made to cultivate this soil, and then only upon the moderately rolling areas.

The more loamy phases produce sufficient grass for pasturage, and sheep do well on such areas. Only fairly good crops are produced under favorable conditions upon the best phases of the type. Corn yields from 10 to 25 bushels, beans from 8 to 15 bushels, and rye from 10 to 20 bushels per acre.

Upon the rough, ridgy areas, which are nothing more than gravel beds, there is only a scanty growth of grass and weeds, mullein being the principal vegetation.

The following table gives the average results of mechanical analyses of fine-earth samples of this soil type:

Mechanical analyses of Miami gravelly sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13381, 14253	Soil	10.8	27.8	16.2	17.6	6.2	12.1	9.6
13382, 14254	Subsoil	12.2	36.1	16.8	17.1	4.6	7.5	5.5

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 13382, 0.7 per cent; No. 14254, 8.5 per cent.

MIAMI FINE SANDY LOAM.[b]

The Miami fine sandy loam is the most important soil type in the area. It is the greatest in extent and ranks first in agricultural value. The soil is a brown sandy loam from 10 to 24 inches deep, underlain by a loam, clay loam, or clay. The soil of the Miami fine sandy loam closely resembles that of the Miami sandy loam, the main difference between the two types being the heavy subsoil of the former. Where the surface is rolling and erosion has taken place knolls of stiff clay are prominent features.

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[a] This is the soil mapped in the adjoining area of Pontiac as Marshall gravel.

[b] This type of soil was mapped in the adjoining area of Pontiac as the Oakland sandy loam.

This type occurs in two phases, differing slightly in texture and depth. Neither phase occurs by itself in any extensive area, nor is one phase confined to any single locality, both phases always occurring closely associated in different parts of the survey. In one phase the brown sandy loam is composed of medium sand, underlain by a loam or clay. The soil has an average depth of 18 inches and is quite uniform in texture. The other phase has a heavier soil, consisting of a fine sandy loam somewhat darker in color. The subsoil is a heavy brown or yellow clay resembling the stiff subsoil of the Miami clay loam. Clay knolls are more prominent in this phase than in the other, while in the depressions the top soil closely resembles that of the Miami clay loam.

Gravelly areas, from 1 to 5 acres in extent, occur scattered through the type. The larger stones have been piled or used in making fences. The type is generally rolling and thoroughly well drained. It occurs in areas of varying size throughout the survey, the largest body being located northeast of Oxford.

Upon the Miami fine sandy loam general farming is practiced, and on account of physical properties and position it is considered the most desirable soil of the area for this purpose. There is but a slight difference in crop yields between the two phases of this soil, except in the driest seasons. Where the sandy soil attains a depth of over 2 feet, which is the exception rather than the rule, there is a slightly reduced crop yield. The stiff clay subsoil usually retains sufficient moisture to withstand periods of drought.

Corn yields from 30 to 75 bushels, barley from 20 to 30 bushels, and beans from 15 to 25 bushels per acre. Clover and timothy grow well, producing from 1½ to 2 tons of hay per acre. Clover is also grown for seed. Peaches, apples, small fruits, and truck crops do especially well.

The following table shows the average results of mechanical analyses of samples of this soil type:

Mechanical analyses of Miami fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13379, 14275	Soil	1.8	7.1	9.4	29.9	15.6	24.6	11.1
13380, 14276	Subsoil	2.0	7.1	7.9	25.5	14.1	24.9	18.3

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 13380, 11.1 per cent.

CLYDE FINE SANDY LOAM.

The Clyde fine sandy loam is a dark-brown loam or heavy fine sandy loam from 8 to 15 inches deep resting upon a subsoil consisting either of a sandy loam, usually yellow in color, or a heavy dark-colored loam. Where the soil occupies low, wet positions there is a covering of black humus from 1 to 4 inches deep. Here the subsoil is usually a light-gray heterogeneous mixture of silt, sand, and medium-sized gravel.

The Clyde fine sandy loam has a nearly level surface, being broken only by low knolls and slight depressions. The natural drainage is poor, and for the most part artificial drainage is necessary before good crops can be secured.

The type occurs typically developed in Oakland Township, in sections 2 and 3, and also in the vicinity of Leonard. These are the largest areas. The type is of very limited extent, covering in all but 1,600 acres, and from an agricultural standpoint is of little importance. Not much of it is cultivated, and the yields are only fair. The Clyde fine sandy loam is used almost exclusively for wood lots and pasturage. Hay produces from 1 to 2 tons per acre. The timber growth consists of elm, oak, and hickory.

The following table shows the results of mechanical analyses of the fine earth of this soil:

Mechanical analyses of Clyde fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14269	Soil	1.5	5.2	8.1	36.1	19.2	20.9	8.7
14270	Subsoil	1.3	5.3	7.6	28.5	24.0	21.3	11.7

MIAMI SANDY LOAM.

The Miami sandy loam is a light to dark-brown medium to fine sandy loam from 10 to 15 inches deep, underlain by a yellow sand or sandy loam of about the same texture. There is nearly always present in both soil and subsoil gravel in varying amounts and sizes, while on the surface there is a generous sprinkling of the same material, and large pebbles and small bowlders are not infrequently met with.

The Miami sandy loam, in extent and agricultural importance, ranks second among the soils of the area surveyed. The largest areas of this type occur in the central and southern parts of the survey. In the vicinity of Oxford it has a level surface, but the topography changes to gently rolling farther south and west. Some of the smaller areas have a somewhat rough, broken surface, with an occasional clay or gravel hill rising above the general level of the type.

The level area near Oxford possesses a slightly heavier subsoil than the typical soil and consists of a light-brown sandy loam containing sufficient clay to make it sticky when wet. It also contains a higher percentage of fine gravel.

This soil on account of its open character is thoroughly drained and can usually be worked two weeks earlier than the heavier soils. At the same time the subsoil, as a rule, is sufficiently compact and retentive of moisture to prevent any serious damage to crops during an ordinary period of drought.

All the crops of the area are grown upon the Miami sandy loam. Corn yields from 25 to 40 bushels, rye from 15 to 30 bushels, oats from 35 to 70 bushels, buckwheat from 15 to 20 bushels, beans from 10 to 20 bushels, hay from 1 to 2 tons, and rutabagas from 400 to 700 bushels per acre. The growing of alfalfa has been attempted with varying degrees of success.

The Miami sandy loam is a strong potato soil, and during wet seasons the yields are better than on the heavier soils. The potatoes grown upon the sandy soils are not so susceptible to blight and rot. Small fruits and vegetables are grown to some extent, and these could be made profitable if more extensively cultivated. Apple orchards in the more rolling sections have proved quite successful.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Miami sandy loam:

Mechanical analyses of Miami sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13373, 14263, 14265.	Soil	2.6	16.7	13.1	35.1	9.3	12.7	6.7
13374, 14264, 14266.	Subsoil	2.2	11.7	15.3	47.8	10.3	7.7	4.6

MIAMI CLAY LOAM.

The soil of the Miami clay loam, to a depth of from 8 to 12 inches, is a heavy brown or drab-colored loam or clay loam. The subsoil is a heavy clay loam or stiff clay with a depth of 3 feet or more. Only a small quantity of gravel is present, but the surface was originally strewn with various-sized bowlders. These for the most part have been removed from the cultivated fields and utilized mostly in making fences or as foundations for buildings.

The Miami clay loam generally occurs in small bodies as knolls and depressions, and is usually associated with the Miami fine sandy loam. The largest and most important area occurs in the southeastern corner of the survey, where the type occupies the rolling upland interspersed with steep knolls and ridges. On some of the steeper slopes and knolls the soil has been entirely removed by erosion, and the stiff clay subsoil is exposed. These clay knolls, which occur not only in areas of the Miami clay loam, but are also found in the Miami fine sandy loam and Miami sandy loam types, are troublesome to the farmer. If plowed when either too dry or too wet the soil forms clods which are difficult to pulverize. These stiff clay patches are often left uncultivated, as the crop returns would not pay for the labor of cultivating them. For the most part the natural drainage of this type is very good; only a few of the smaller areas, occurring as depressions, would be much benefited by artificial drainage

All the general farm crops of the area are grown on the Miami clay loam. It is an ideal corn and grass soil, and is well adapted to dairying and stock raising. Corn yields from 40 to 60 bushels, oats from 40 to 60 bushels, wheat from 15 to 25 bushels, rye from 15 to 25 bushels, and hay from 1 to 3 tons per acre. The Miami clay loam supports a heavy growth of hickory, maple, beech, oak, and other varieties of hardwoods. It is the heaviest and strongest soil of the area.

The following table shows the average results of mechanical analyses of typical samples of the Miami clay loam:

Mechanical analyses of Miami clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13377, 14271	Soil	1.7	4.1	4.7	16.4	14.2	38.4	20.1
13378, 14272	Subsoil	.3	1.2	1.4	6.0	9.7	46.9	34.1

AGRICULTURAL CONDITIONS.

The area surveyed, taken as a whole, is no excepton to the general prosperity noticeable throughout Oakland County. The farm buildings, as a rule, are neat and commodious. The barns are modern and well constructed, often costing more than the dwelling. The cost for constructing the average size gambrel-roof barn, as seen in this area, ranges from $1,000 to $3,000.

Occasional springs are seen, and in the western part of the area artesian wells are not uncommon, and are numerous in the vicinity of Ortonville. Nearly every farmer has a windmill and a covered tank to supply water for domestic use.

Stones and bowlders are common over the entire area, and, as elsewhere stated, are gathered from the fields and utilized for making fences and as foundations for buildings. The stone fence consists of medium-sized stones piled one upon another, with a shingle between, to a height of 2 or 3 feet, and above this there are usually strung 2 barb wires, thus making a very substantial and durable fence. A few rail fences are still seen, but these are fast giving place to wire fences.

Upon the Miami gravelly sand and the rough Miami gravelly sandy loam areas the signs of prosperity seen elsewhere are generally lacking, and not until some special crops are introduced will conditions be bettered in these localities.

The fact that the greater number of the farmers own their farms and operate them personally accounts in part for the prosperous condition of this area. Few tenants take the same interest in a farm and as good care of the buildings as does the owner, and in time the results of neglect become noticeable. A few retired farmers have moved to town, and rent their farms.

The census of 1900 shows that 66.5 per cent of the farms of Oakland County are operated by the owners. Leasing of land is conducted both on a cash and share basis. The cash rent is usually from $2 to $2.50 an acre. Under the share system the owner furnishes one-half of the seed and stock and receives one-half of the crops and increase. According to the census of 1900 the average size farm contains 110.2 acres. Labor can usually be secured for $25 a month, with board in addition, but for the greater part of the year the farmer does his own work. Improved machinery, such as potato diggers, corn cutters, bean harvesters, and hay loaders, has to a certain extent simplified the labor question.

The principal agricultural products of the area are corn, oats, rye, potatoes, and beans. Corn is not grown for the market, but is fed on the farm. Potatoes are extensively grown and usually command a good price. Large shipments are made each year, and they may be said to be the money crop of the area. Sometimes the blight decreases the usually large yields, but it does not make its appearance regularly each season. The sandy soils are well adapted to this crop, as high as 300 bushels per acre being secured. Rutabagas are also quite generally grown, with yields varying from 400 to 800 bushels per acre. Beans produce well and are usually grown upon the sandy soils. At Oxford a mill is operated where the beans are cleaned, sorted, and polished for the market. Other crops of lesser importance are buckwheat, onions, carrots, turnips, and cabbage. These all find a ready market, and trucking on a large scale would prove a remunerative business.

Both the Miami black clay loam and Miami fine sandy loam would doubtless prove good sugar-beet soils, but at present none are grown. Peaches and apples are the most important fruit crops of the area. The sandy and gravelly soils produce a good quality of fruit. With careful cultural methods along scientific lines the growing of both apples and peaches should be highly profitable. Grapes, plums, cherries, and pears do well, but are not grown extensively.

General farming, regardless of the adaptability of certain soils to certain crops, has until recently been the rule. The good results obtained by specialized farming are, however, fast being recognized. Wheat at one time was generally grown on all the soils, but for the last few years the acreage of this crop has been gradually growing less. This change has been brought about by the decreasing yields due to continued cropping and to the damage done by the Hessian fly.

Dairying is carried on to some extent. Excepting that used for local consumption, the milk is made into butter and shipped to Detroit. Homemade butter is always in demand, and an agreement to furnish a certain quantity each week to customers is often made. Some sheep are raised and are found to be quite profitable. Dairying and stock raising could be profitably extended.

The silo, very little used in the area at present, could be used to great advantage. Late corn or corn sown with this purpose in view, when cut green and stored in silos, furnishes an excellent feed for both dairy and market cattle.

Alfalfa has been tried to a limited extent. At Orion a small field that was doing well was seen on the Miami sandy loam. It had been cut three times during the season, and in October was furnishing excellent pasturage. Alfalfa is difficult to start, and in attempting to grow it many farmers become discouraged. In getting a stand the weeds are inclined to crowd the alfalfa out, and frequent cuttings are necessary to keep the weeds back. No attempt should be made to gather the first cutting or the one made while the plant is in bloom. If left on the ground the soil is greatly enriched and the plants strengthened. A few acres in alfalfa were also noted at Oxford, and the crop was doing well. The introduction of this crop into the rotation would prove of great value to this section, as it is valuable both as a forage crop and as a soil renovater.

The area is well supplied with transportation facilities. The Michigan Central Railroad, running from Detroit to Mackinaw, passes through the central part of the area from north to south. The Pontiac, Oxford and Northern Railroad passes through the south central and northeastern part of the area. Besides the steam railroads the Flint Division of the Detroit United Electric Railway connects the area direct with Detroit and Flint. This line carries large quantities of all farm products. Much of the produce, including poultry, is shipped from Oxford, the largest town of the area. Orion, Clarkston, Leonard, and Ortonville are local markets of less importance.

SOIL SURVEY OF NEWTON COUNTY, INDIANA.

By **N. P. NEILL** and **W. E. THARP.**

LOCATION AND BOUNDARIES OF THE AREA.

Newton County lies in the northwestern part of Indiana, bordering the Illinois State line. It is bounded on the north by Lake County, from which it is separated by the Kankakee River; on the east by Jasper County; on the south by Benton County, and on the west by the State of Illinois. Newton County is quite regular in outline. Its average length north and south is 30 miles and its average width east and west is 13 miles. The area included within these boundaries is 251,448 acres, or, approximately, 393 square miles.

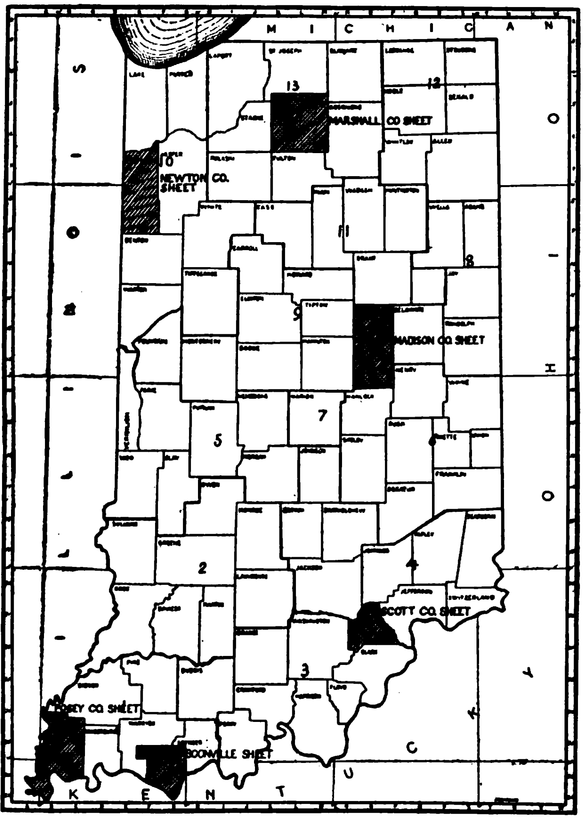

FIG. 32.—Sketch map showing location of the Newton County area, Indiana.

Goodland, Kentland, and Morocco are the principal towns in the county.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The original county of Jasper, which was organized in 1838, formerly embraced the territory included within the present limits of Newton and Jasper counties. Owing to the large size of the county and the great distance of the outer portions, especially the western, from the county seat, it was divided. The separation was made in 1859, with the county seat of Newton County located at Kent, now Kentland.

It is quite difficult to determine who were the first settlers to come into this locality. The county was originally a wet, marshy country, covered for the most part with a heavy growth of prairie grass, with some timber along the streams, and inhabited by a large number of fur-bearing animals. These animals attracted the early hunters and trappers into this section of the State, and in some cases temporary settlements were made along the streams.

Prior to 1850 society had little organization. The population was small and scattered over considerable territory, except in one or two localities. The principal early settlements were made on timbered areas along the Iroquois River, in the eastern part of the county. The early settlers came principally from southern Indiana, but most of them were natives of Virginia, Kentucky, Pennsylvania, and Ohio. In later years, as the county became better developed, the immigrants came chiefly from New York, Maryland, and Illinois. The growth and development of the county was at first greatly retarded by trouble with the Indians and later by a class of outlaws who made this territory their field of operation.

Aside from these retarding influences the prairie fires were the most dreaded of all early contingencies with which the settlers had to deal. Various means were resorted to for protection against these fires, but often, when driven by high winds, they would leap any barrier that could be constructed, and buildings, crops, and all improvements would be destroyed, and the settler was often fortunate to escape with his life.

Prior to 1860 the county had no railroads, no newspapers, and but few inhabitants. About 1853, however, the county began to develop gradually, and the advent of the railroad in 1860 gave its growth a decided impulse.

The early settlers brought only the actually necessary outfits with which to begin farming operations in this new territory. They generally came in wagons drawn by horses or oxen, and as a rule followed old trails made by the Indians. The roads over which they passed were bad and at times almost impassable, and under such conditions only the necessities of life were brought with them. The farmers depended upon the near-by villages or settlements for such farming implements as could be obtained. The plow then used was a crude, ungainly implement and not capable of breaking up prairie lands. For this reason the early inhabitants settled on the timbered areas along the streams. Here the land had been heavily shaded and was free from the tough grass roots of the prairie, and when cleared was more easily cultivated. But as it became necessary to break up the prairie lands a heavy sod plow was developed, and while it was a crude, poorly constructed implement, nevertheless it revolutionized the farming of early days. The plow consisted of a beam 10 or 15 feet in length, a share that would cut about 2 feet in width, and a moldboard made of iron bars. It generally required six yoke of oxen to draw it, but the expenditure of all this labor was usually repaid the first year. The second year a "cary" or two-horse side plow was used, which, together with the hoe, was the only implement used until harvest time, when the reap hook, cradle, scythe, and flail were employed.

Each settler brought his cattle and horses with him. Horses were used at first, but later oxen proved to be more serviceable in breaking up new land. A few hogs were raised, which furnished the farmer with meat and occasionally added a little to his income. The wild prairie grass furnished feed for most of the stock, and only a small amount of corn was fed.

Corn was generally the first crop planted. It was dropped in the edge of the furrow while the sod was being turned under. The crop produced was small and of inferior quality. Wheat was occasionally grown, but not very successfully. It generally grew too rank or succumbed to attacks of insects or unfavorable climatic conditions.

The agricultural development of the county was at first greatly retarded by the lack of local markets and the great cost of transporting the produce to distant ones. Later, however, as public roads were improved and the towns and local markets were built up development became more rapid. Morocco, the oldest town in the county, was established in 1851. In 1860 the town of Kent, now Kentland, was founded, and in the following year Goodland was laid out.

In later years, as the prairie lands were being put under cultivation, the settlers aimed to improve first such lands as possessed good natural drainage, avoiding wet and poorly drained areas. Corn, oats, wheat, and hay were the chief products. Wheat formerly produced good yields, but in later years its production proved unsuccessful. The great freeze of 1871–1873 was the death blow to wheat growing in this county. Several attempts were afterwards made to produce this cereal, but they were generally unsuccessful.

In 1871 wild land was valued at $20 an acre, and in 1872 it was worth $25 an acre. During the five years following land advanced in price in proportion to the amount of improvement put upon it. The wet season, which covered a period from 1882 to 1886, brought the price of land down to about $10 or $15 an acre. The farmers then began tiling and draining the lands, and since that time land has gradually advanced in price.

Fifteen years ago cattle and hogs were raised more extensively than at present. The low price of beef and pork, together with the prevalence of hog cholera, was the cause of the decrease in their production. During recent years, however, the stock industry has been gradually improving and at present a large proportion of the county, particularly the northern, is devoted chiefly to stock raising and dairying.

CLIMATE.

No data giving the normal monthly and annual temperature and precipitation of Newton County were obtainable. The appended table gives the weather records taken at Rensselaer, which is only a few miles east of the area, and Hammond, which is situated in the county north of Newton:

Normal monthly and annual temperature and precipitation.

Month.	Rensselaer.		Hammond.		Month.	Rensselaer.		Hammond.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	*Inches.*	*° F.*	*Inches.*		*° F.*	*Inches.*	*° F.*	*Inches.*
January	32.6	2.91	23.4	2.37	August	74.5	2.30	71.0	1.97
February	24.8	3.00	22.2	2.10	September	66.2	1.59	65.4	2.70
March	41.6	5.05	36.0	....	October	57.8	3.03	54.6	1.79
April	51.0	2.03	47.2	2.64	November	44.6	3.43	38.0	2.15
May	62.8	3.36	58.5	4.68	December	29.8	2.78	26.2	2.38
June	69.2	5.61	68.8	3.95	Year	52.6	38.97	48.8	....
July	76.4	3.88	73.7	2.64					

The climate of Newton County is humid. The rainfall is quite evenly distributed throughout the year. During the growing season it is greatest during the months of May, June, and July, averaging about 4.28 inches for each month, the heaviest precipitation occurring during the month of June, averaging 5.61 inches. The total yearly precipitation is 38.97 inches.

The average annual temperature is about 52.6° F. The coldest months of the year are December, January, and February, the average temperature for these months being 29° F. There are periods during the winter months when the temperature falls considerably below the average, but such cold periods seldom last more than a few days.

The warmest period of the year occurs from June to August, the average temperature being 73.3° F. During these months the temperature often rises as high as 90° F., but such warm periods only last for two or three days at a time.

A very important and characteristic feature of the climate is the occurrence of strong winds during the late spring and early fall months. Periods of strong winds often extend over a number of daysand during the latter part of the growing season, especially if the rainfall is light, these hot dry winds sweeping over the area rob the soil of considerable moisture and crops are more or less injured.

The average date of last killing frost in the spring is April 30 at Rensselaer and April 20 at Hammond; the average date of first killing frost in the fall is October 5 for the former place and October 23 for the latter. On the low wet lands of the area frosts generally occur later in spring and earlier in fall than is shown by the above dates.

PHYSIOGRAPHY AND GEOLOGY.

The area surveyed lies north of the hydrographic basin of the Wabash River. It is separated from this basin by a low ridge, the northern slope of which embraces a small portion of the southern part of the county. The surface in this locality is slightly undulating and rolling and occasionally broken by small narrow valleys which have been formed by streams having a northerly direction. The general fall is to the north, and as the Iroquois River is approached the surface becomes more level. This portion of the area embraces a part of the typical prairie lands of the northwestern part of Indiana, and the surface for the most part represents a level plain. It is, however, quite frequently broken by small ridges. They occur most frequently along the eastern border of the area north of Goodland, although a number of them are scattered over this portion of the county. The ridges have a general east and west trend and vary in elevation from 10 to 20 feet above the mean level of the surrounding territory. The most important of these ridges occur on each side of the Iroquois River in Washington and Jefferson townships. Here they flank a narrow valley through which the river flows. They are well defined and extend back on each side of the stream for an average distance of about one-fourth mile.

The valley formed by this stream is narrow and only for a part of its course are second bottoms developed. These occur within the eastern half of the area, where the valley has an average width of about one-eighth mile. North of the Iroquois River, and particularly in the eastern part of Washington Township, the surface is almost a dead level with only a slight fall to the south. The western part of this township is more rolling and hilly.

The most conspicuous topographic feature of the county is the broad ridge which crosses it in a northeasterly and southwesterly direction about 5 or 6 miles north of the Iroquois River. This ridge forms the watershed between the waters of the Iroquois and Kankakee rivers, and is referred to geologically as the Iroquois moraine. The surface of this moraine is decidedly undulating and rolling, and rises to an average elevation of about 700 feet above sea level. It has an average width of about 4 or 5 miles, being somewhat wider in the eastern than in the western part of the area.

North of this ridge the general fall is toward the north. The general aspect of this part of the county is that of a low, marshy plain, broken by innumerable hills and ridges of various elevations and a few swampy depressions. This district is plainly lacustral in its characteristics. The sloughs, swamps, and marshy areas indicate the beds of ancient lakes, and the low sand ridges mark, in many cases, old shore lines. Some of the beach lines can plainly be traced in the areas of Newton fine sand.

The prominent topographic features of this section are the many small hills and ridges scattered over the area. They are largely the result of wind action, and vary in height from 2 to over 150 feet and in breadth from less than 100 feet to over 1 mile. Between these ridges narrow strips occasionally occur with nearly a plane surface. Some of these ridges, particularly those having a low elevation, occur in clusters or are grouped together in the form of a chain.

The land bordering the Kankakee River is somewhat lower than it is farther back from the stream and is under water a greater part of the year. A more detailed description of the surface features of the county will be given later in the descriptions of the various soil types.

The drainage waters of the southern part of the county, south of the Iroquois Ridge, empty into the Iroquois River. This stream flows in a southwesterly direction across the county about 4 miles north of Kentland. North of the ridge the greater proportion of the drainage water flows to the north and empties into the Kankakee River. However, a part of these lands is drained by the Beaver Creek ditch, which flows in a westerly direction and empties into the Iroquois River in Illinois. This stream formerly drained the old Beaver Lake district.

Later the old State ditch, which is now known as the Beaver Lake ditch, was built and the waters of this district were turned into the Kankakee. The Beaver Lake ditch is the largest stream emptying into the Kankakee in Newton County. A number of other smaller ditches have been constructed which drain into this river.

The glacial drift that occurs over the area south of the northern base of the Iroquois moraine is correlated with the late Wisconsin drift sheet.[a] The surface material consists of sand, sandy loam, and loam, except in cuts or on the more pronounced slopes of some of the ridges constituting the Iroquois moraine, where the unweathered till is exposed. The drift varies in depth from 60 to 150 or more feet, and is composed of a mixture of clay, sand, and gravel in varying proportions, with gravel generally increasing in size and amount with depth. Associated with this material are deposits of pure sand and gravel. Many of these gravel knolls have been opened and the gravel used for road building.

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[a] Monograph No. 38, U. S. Geological Survey.

Large glacial bowlders also occur scattered over the surface of the greater part of the area, particularly on the prairie lands, and in a few areas on the moraines. These bowlders, which consist chiefly of granites, occasionally occur so plentifully as to interfere with cultivation, but in most cases they have been removed from the fields.

Another but much smaller moraine extends east from Percy Junction to the eastern boundary of the area. This ridge, which is composed largely of sand, forms the most southern of the sand areas of Newton County. Other sand areas occur north and northwest of these ridges, but they have no definite connection with one another or with the one just described.

North of the Iroquois moraine the soils are largely of lacustral origin and belong to the Lake Kankakee period. The flat areas are largely composed of sand, and heavy peat beds are quite common. In some areas peaty material is found underlying the sand, which denotes a period or interval of emergence or exposure to the atmosphere between the withdrawal of the ice sheet and the deposition of the sand over these deposits.

In a few areas in the southern part of the county Niagara limestone is found at a depth of only a few feet. In section 25 of Jefferson Township limestone is quarried and used for road building. The limestone is covered over with glacial material and has played no part in the formation of the soils of the area.

SOILS.

Eleven distinct soil types were recognized and mapped in the area surveyed. Each of the types is quite distinct in its typical form, although, as in nearly all glaciated areas, minor variations from the true type occur. The line of demarcation between the various soils is generally quite well defined, but in some cases the transition from one type into another is gradual and occasionally almost imperceptible. The typical prairie soils of the area are separated from the original marsh soils, which occupy the northern part of the county, by the Iroquois moraine. Covering this moraine and south of it four distinct types are recognized, while to the north of it and including the soils mostly of lacustral origin seven types are found.

The following table shows the extent of the several types:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall loam	81,856	32.8	Swamp	3,648	1.4
Clyde fine sand	61,048	24.4	Miami black clay loam	1,792	.7
Marshall fine sandy loam	42,560	16.8	Clyde loam	960	.4
Miami fine sand	32,704	13.0	Kaskaskia loam	832	.3
Peat	10,368	3.9	Total	251,448	....
Marshall fine sand	9,792	3.9			
Newton fine sand	5,888	2.4			

MARSHALL FINE SANDY LOAM.

The soil of the Marshall fine sandy loam consists of a medium to fine sandy loam, with an average depth of about 14 inches. It generally contains a very high percentage of organic matter, and to this is due its characteristic black or dark-brown color. As the depth of the soil increases the amount of organic matter gradually decreases and the color becomes correspondingly lighter. The texture of the soil is quite uniform, but the depth varies from about 8 to 20 inches, depending upon topographic position. On the crests of knolls and ridges it is generally of a more sandy nature and is more shallow than in the depressions, where, besides being usually deeper, the texture is somewhat heavier, in some cases approaching a silty loam. This is not always the case, however, and a few areas were found in which the soil on the higher elevations of the type was heavier than that occupying the lower areas. This latter variation generally occurs where the soil is quite shallow and rests directly upon bowlder clay. In this case considerable of the underlying clay has become more or less mixed with the soil, giving it a somewhat heavier character. The color of the soil in these localities is also somewhat lighter than it is in typical areas.

At a depth of about 14 inches the soil grades into a medium to fine yellow sandy loam subsoil, in which there is generally found considerable clay. The subsoil gradually becomes heavier with depth, grading into a mottled yellow sandy clay, which is quite sticky when wet and which usually extends to a depth of 36 inches. In some instances, however, the percentage of sand increases with the depth of the subsoil, and occasionally a layer of sand, seldom over 2 or 3 inches in thickness, is encountered. Such areas as these generally occur in the vicinity of sand ridges. These sandy layers are in turn underlain by a sandy clay varying in color from light or orange yellow to gray. The subsoil varies to a marked degree in different parts of the county. This fact is of considerable importance, inasmuch as it has a controlling influence upon the character and yield of crops grown. Generally till is encountered beneath this type of soil at a depth of from 3 to 4 feet.

It consists of a mixture of clay, sand, and gravel of varying proportions, with gravel generally increasing both in size and quantity with depth. In the upper portions of this till the gravel is about the size of a pea, while at lower depths it varies in size from a fraction of an inch to 3 or 4 inches in diameter. Occasionally some fine gravel occurs on the surface of the type, but this is of little or no consequence. A few large bowlders are also found on the surface of this soil, but in most cases they are directly associated with the Marshall loam. In certain areas of the Marshall fine sandy loam, especially where the surface is very rolling or hilly and particularly on the crests of some of the moraines, the till is covered only to a depth of a few inches by fine sandy loam. This feature is especially noticeable in sections 32 and 33 of Jackson Township. Here the till, consisting chiefly of clay mixed with some sand and considerable gravel, outcrops on the slopes of the ridges. The color is generally reddish yellow, occasionally slightly mottled. The till found underlying the soil of lower levels is generally light yellow.

The following table gives the average results of mechanical analyses of typical samples of this soil type:

Mechanical analyses of Marshall fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12780, 13127	Soil	0.4	2.2	8.6	40.7	13.3	21.8	13.0
12781, 13128	Subsoil	.3	3.0	8.0	41.7	13.8	20.3	13.0

The Marshall fine sandy loam occurs almost wholly north of the Iroquois River, being the chief type occupying the Iroquois moraine. In this locality it occurs in one body continuous across the county, though interspersed with many areas of other soil types. In no case is it found north of the northern base of this ridge. A few comparatively small areas occur as isolated patches south of the Iroquois River. They occupy the more elevated positions or ridges in the Marshall loam areas. The two largest of these bodies occur along the Iroquois River in Jefferson and Washington townships.

The surface of the greater proportion of the area occupied by this type is undulating and rolling. In only one or two instances is the surface level, and in these cases the level areas are comparatively small. The most conspicuous topographic features of this type are the two large ridges on each side of the Iroquois River in Jefferson and Washington townships. The isolated areas in the southern part of the county occur mostly as small ridges, seldom over 4 or 5 feet above the level of the surrounding country, while in sections 25 of Jefferson Township and 30 of Grant Township the type occurs as one large knoll.

The character of the surface of the Marshall fine sandy loam affords excellent natural drainage, but it is a generally recognized fact that artificial drainage greatly increases the productiveness of the soil, particularly where it is underlain by a heavy subsoil. The lighter areas, especially where the subsoil is sandy, are not so much in need of artificial drainage, but nevertheless it should be encouraged on both the light and heavier phases of this type, inasmuch as crops suffer materially from an excess of moisture during wet seasons.

The soil for the most part is derived directly from the glacial till, but some areas have been formed by the mixing together of the fine sand and loam types, forming in this case the transitional phase between the Marshall fine sand and the Marshall loam. In addition to this there has been incorporated in the soil a very high percentage of organic matter through decay of a luxuriant growth of vegetation.

The Marshall fine sandy loam is one of the most productive soils in the area and is adapted to a greater diversity of crops than is at present grown upon it. The type in this locality is devoted chiefly to the production of corn and oats, the staple crops of the county. Bluegrass grows very well, and timothy and clover are grown to some extent, but it is generally quite difficult to obtain a good stand of clover on account of the dry, hot winds and dry weather which often follow the removal of the nurse crop. Wheat is grown only on this soil. Its production, however, is limited, owing to poor and uncertain yields. Very few vegetables are grown, except for home use. Potatoes do fairly well, but their yield is uncertain. Only the early varieties of this crop are grown. Of the small fruits, berries do best on this type. Some currants are grown, but they do not yield well. Sour cherries and apples are the principal orchard fruits produced.

The average yields of the crops produced on this soil vary somewhat in different parts of the county, depending largely upon the character of the subsoil and climatic conditions. During dry seasons that portion of the type possessing a heavy subsoil generally gives the better results, inasmuch as it is able to withstand droughts better, while during unfavorably wet seasons the areas having a light subsoil and better drainage give the better results. In former years this type produced on the average about 50 bushels of corn and an equal quantity of oats to the acre. During recent years, however, there has been a gradual falling off in the yields of crops grown, until the average of corn and oats produced seldom exceeds 35 or 40 bushels. The yields, however, vary considerably with different seasons. The estimated yield of wheat is given at about 12 or 15 bushels, if grown under favorable conditions. Timothy and clover average from 1 to 1½ tons per acre. Potatoes vary considerably, and, although as many as 200 bushels have been produced, the average yield is about 50 bushels per acre.

The manurial requirements of this type were investigated, using a large sample from a field three-fourths of a mile south of Morocco. The soil is a black to dark-brown medium fine sandy loam and the field is well drained. It has been in cultivation for more than twenty years, corn and oats being the chief crops. Small to medium quantities of stable manure are used, but no other fertilizers. Yields of both corn and oats average about 40 bushels per acre.

The results of the examination of this sample by the wire-basket method indicate that stable manure has a large effect in increasing the growth of crops, and that sulphate of potash and nitrate of soda used either alone or in combination have very little effect. Lime and acid phosphate, either separately or in combination with the above-mentioned fertilizers, failed to give any appreciable increase in growth. These results were obtained under favorable climatic conditions for the crop and with the soil in the best possible physical condition. They indicate that the practice of the locality in applying barnyard manure is commendable.

MARSHALL LOAM.

The Marshall loam, to an average depth of about 14 inches, consists of a dark-brown or black loam. The soil generally becomes heavier with depth, and under field conditions the texture appears rather silty, due in part to the presence of a very high percentage of organic matter which is everywhere found in this soil, and to which is also due its characteristic dark color.

The depth of the soil varies in different localities, depending largely upon topographic position. In the local depressions and in the more level areas the soil is much deeper than the average, ranging from 16 to 18 inches, and in some cases to 24 inches. In such areas the soil is generally of a somewhat heavier nature than that occurring on the more uneven places. On the low knolls and ridges the depth of the soil varies from 6 to 8 inches, and the texture is more sandy, occasionally approaching a heavy sandy loam. Near the main streams and over areas affected more or less by erosion the type is generally a heavy loam, with the color lighter than in the typical areas, the depth in this case being also less. This phase is particularly well developed along the Iroquois River.

The line of demarcation between the soil and subsoil is generally well defined. At a depth of from 12 to 14 inches the soil grades into a yellow light clay loam in which the clay content increases with depth. The color is often a mottled yellow in the lower portions, and occasionally this material extends to a depth of over 3 feet. In most cases, however, at a depth of from 25 to 30 inches it grades into a sandy clay in which the sand content is large, and finally, at from 30 to 36 inches, there occurs a layer of sand and fine gravel mixed with a sufficient amount of clay to give it a sticky consistency when wet. As a rule the deeper subsoil is a heterogeneous mass of clay, sand, and fine gravel, and this generally comes to within 36 inches of the surface. Occasionally some fine gravel is found on the surface and scattered through the soil, but this occurs in limited areas and does not affect the agricultural value of the land. Large glacial bowlders are found scattered over some areas of this soil, in some areas so plentifully as to interfere with cultivation, though in most cases they have been removed from the fields.

There are a number of unproductive spots in the Marshall loam that are locally called "alkali spots." Their unproductiveness, however, is not due to the presence of alkali salts. Before this part of the county was drained these areas, which occupy depressions too small to be shown on the map, were known as "sink holes" or "quicksand" areas, and the soil is now generally somewhat more sandy than the neighboring productive lands, while the subsoil is largely composed of sand. Liberal applications of stable manure increase the productiveness, and large quantities of straw have been burned on them with good results.

The average results of mechanical analyses of typical samples of fine earth of this type are shown in the following table:

Mechanical analyses of Marshall loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12784, 13107, 13111.	Soil	0.6	3.2	4.4	21.6	9.1	36.8	23.9
12785, 13108, 13112.	Subsoil.....	.9	4.1	4.8	20.4	9.2	33.1	27.3

The Marshall loam occurs most extensively developed in the southern part of the county, embracing the greater proportion of the area south of the Iroquois moraine. It occurs as one continuous body over this part of the sheet, while north of this main body are found isolated areas covering the local depressions in the morainic ridge. Like the Marshall fine sandy loam, this soil does not occur north of the northern base of this ridge.

The surface of the Marshall loam is mainly a level plain sloping gradually toward the Iroquois River, which crosses the county from east to west. In the extreme southern part of the county the surface is gently rolling and occasionally broken by shallow valleys, formed by the small northward-flowing streams. As the river is approached the surface becomes more level. North of the river the surface is almost a dead level, with only a slight fall toward the south. In many areas the surface is broken by a number of low sand and sandy loam ridges, seldom exceeding an elevation of 6 or 8 feet above the surrounding levels. Where these ridges are of sufficient size they have been shown as different types of soil.

The drainage conditions of this soil vary in different parts of the county, depending to a marked degree upon the topographic features. On the more rolling areas the natural drainage features are well developed, while over the more level areas artificial drainage has to be resorted to in order to insure the production of good crops. Most of these lands can be economically drained, and already a large proportion of their area is tiled. There are a number of small ponds, sloughs, and depressions which have little or no outlet, and while some of these can be and have been economically reclaimed, it is doubtful if many can be profitably drained, as the cost of constructing outlets sufficient to secure good fall would probably exceed the value of the land.

The Marshall loam is derived from glacial material correlated by Leverett with the late Wisconsin drift sheet. Mingled with the soil and subsoil are many pebbles and bowlders. The bowlders, which consist chiefly of granites, are directly associated with this soil and in only a few cases were they found on any other type. To the material deposited by the glaciers large quantities of organic matter have been added by the decay of a luxuriant growth of prairie vegetation which formerly covered this region.

The Marshall loam is admirably adapted to the production of corn and oats, and up to the present time has been devoted almost exclusively to the cultivation of these crops. The yields vary widely with the season, but the average for corn is about 40 bushels and for oats from 35 to 45 bushels per acre. The yields were formerly higher than at present, having declined as a result of the almost continuous production of these two crops for the last twenty or thirty years. Timothy and clover are grown to some extent, but considerable difficulty is often experienced in getting a good stand of these crops. They are very frequently sown together and yield from 1 to 2 tons per acre. Bluegrass does very well and is often sown in connection with white clover and used for pasture. Fruits and vegetables are grown only for home use. Apples and cherries, with some of the small fruits, chiefly berries, produce the best results. Irish potatoes, as well as most of the early vegetables, can be successfully grown, but up to the present time have been raised only for home consumption.

A test was made to determine the manurial requirements of this type, using a large sample collected about 1½ miles west of Goodland. The soil here consists of a dark brown to black heavy silt loam, and the sample was taken to a depth of 6 inches. The land has been in cultivation for from twenty to thirty years, the chief crops being corn and oats with some grass. Moderate applications of stable manure are used, but no other fertilizers. Yields of both corn and oats average about 40 bushels per acre, while hay averages about 1½ tons per acre.

The results of the examination of this sample by the wire-basket method indicate that stable manure has a large effect in increasing the growth of the crop. Results obtained with nitrate of soda, sulphate of potash, acid phosphate, and lime, used separately and in various combinations with each other, were small, and were no greater when two or more of these substances were used in combination than when one was used by itself.

These results are held to be applicable only to the field from which the sample was taken, but it may be stated that they agree well with the experience of farmers upon this type of soil.

MARSHALL FINE SAND.

The Marshall fine sand, to a depth of from 10 to 20 inches, consists of a medium to fine sand, varying in color from light to dark brown, according to the proportion of organic matter present. The color generally becomes lighter as the depth increases, changing to yellow, but the texture of the subsoil remains about the same as that of the surface soil, though generally possessing less coherency. The loamy nature of the soil, particularly in the first 6 inches, is due in part to the presence of a small percentage of silt and clay, but chiefly to the presence of a relatively large amount of organic matter. The yellow subsoil generally extends to a depth greater than 3 feet, but occasionally at from 25 to 30 inches it becomes a mottled yellow, streaked with gray and white sand.

The Marshall fine sand is fairly uniform throughout its occurrence in the area, the chief variation being the presence of some fine gravel. It is seldom, however, that gravel is found upon the surface, though in some areas it is frequently encountered at a depth varying from 20 to 36 inches or more. The gravel is fine, seldom exceeding 3 or 4 inches in diameter, and is used quite extensively for road building.

The following table shows the results of mechanical analyses of typical samples of this soil type:

Mechanical analyses of Marshall fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12782	Soil	0.0	1.7	7.5	52.6	19.2	9.8	9.1
12783	Subsoil	Trace.	1.6	9.0	53.3	18.3	9.1	8.7

The Marshall fine sand is confined to the hills and ridges, but occurs throughout the area surveyed. It is most typically developed in the eastern part of the county, where the ridges are low and narrow, seldom exceeding an elevation of from 10 to 20 feet above the lowest depressions in their immediate vicinity, and varying in breadth from 200 to 300 feet to nearly one-half mile. The type frequently caps the more elevated areas in the Marshall fine sandy loam. The natural drainage conditions are good. In some areas the drainage is excessive, and while it retains moisture well for a soil of this character, crops often show the effects of drought.

The Marshall fine sand is of glacial origin, but the exact manner of its formation is not understood. It is probable that the materials represent deposits of glacial outwash made during the recession of the ice sheet, which have since been modified to some extent by the action of wind.

Corn, oats, rye, and timothy are the principal crops grown on this soil. The yields are generally small and uncertain, but are larger in wet seasons than in dry. The soil is well adapted to the production of vegetables and melons, and their cultivation should be encouraged.

MIAMI BLACK CLAY LOAM.

The surface soil of the Miami black clay loam, which is the heaviest type found in the area, consists of a heavy loam or clay loam, carrying silt and clay in about equal proportions. The average depth of the soil is about 18 or 20 inches, but in some cases, especially in the central parts of the areas, the depth may be as much as 2 feet. Relatively large quantities of organic matter are found in the soil, and to this is due its prevailing black or dark-brown color. As the depth increases the percentage of organic matter decreases, and at 8 to 14 inches the color has a bluish or grayish tinge. The soil is very cohesive and when moist pulls up in large masses around the auger. If allowed to dry without stirring it has a tendency to puddle and bake, and cracks from 1 to 2 inches across and from 1 to 2 or more feet in depth intersect the surface in all directions. If plowed when too wet large clods form, which are difficult to pulverize until moistened again by rain.

At from 18 to 20 inches below the surface the soil grades into a heavy clay loam subsoil, in which the clay content increases with depth. The color of the upper part of the subsoil varies from light to dark gray, depending largely upon the percentage of organic matter present. Generally at a depth of about 20 or 25 inches the subsoil grades into a light-gray or mottled-yellow sticky, impervious clay, which extends to a depth of 3 feet or more.

The following table gives the average results of mechanical analyses of this type:

Mechanical analyses of Miami black clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12969, 13181	Soil	0.1	7.3	6.6	17.9	5.8	34.4	27.8
12970, 13132	Subsoil	.1	.9	1.4	6.0	2.4	27.2	61.4

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12970, 1.83 per cent.

The Miami black clay loam occupies only a very small percentage of the area surveyed. It occurs as basinlike depressions between the low hills and ridges and is most typically developed north of the Iroquois River, occupying only limited areas scattered over that part of the county covered by the Iroquois moraine. The surface is generally level, but in some cases a few small shallow ponds and sloughs occur, the result of obstructed drainage.

Owing to the level character of the topography of this type and to the imperviousness of the soil and subsoil the natural drainage conditions are very poor. In a number of cases artificial drainage has been employed, and this should be done wherever practicable.

The material composing the Miami black clay loam is primarily of glacial origin, but since its deposition it has undergone considerable modification. Prior to the construction of drainage systems sufficient to carry off the surplus water the areas occupied by this type were covered with swamps and marshes. Through the growth and decay of a luxuriant vegetation a large amount of organic matter has been incorporated in the soil, the rapid oxidation of which was prevented by the moisture conditions. Some of the finer particles of soil have been washed into these depressions from the surrounding higher land, and this has had considerable effect on the texture of this type.

The Miami black clay loam is considered one of the best types in the area for the production of corn. When well drained and with favorable climatic conditions it produces on the average about 45 bushels per acre. Although there is danger from lodging, the average yield of oats is estimated at from 35 to 40 bushels per acre. This type is also well adapted to the production of clover and timothy, the latter yielding from 1 to 2 tons of hay per acre. Only the better drained areas are suited to clover, because in the low wet areas the clover heaves badly.

CLYDE LOAM.

The soil of the Clyde loam is a heavy loam or clay loam, varying in depth from 18 to 30 inches. It is of a decidedly black color, owing to the presence of a very large proportion of organic matter, which is generally well distributed throughout the soil profile. The quantity gradually decreases, however, with depth, and the color becomes correspondingly lighter. In some cases, at from 12 to 20 inches, the color is a dark-reddish or brownish yellow, due probably to the oxidation of iron. Iron occurs quite abundantly in the soil and subsoil of this type in irregular masses, varying in size from a fraction of an inch to 1 foot or more in diameter.

Variations in the texture of this type occur near the borders of the sand ridges, where the soil is mixed with varying amounts of sand and approaches a heavy sandy loam. The transitional zone between this soil and the sandy soil is generally quite narrow, and in some cases the line of demarcation is sharply defined.

The subsoil varies in different parts of the area. Near the outer margin it generally consists of medium to fine sand, the latter grade predominating. The upper portion of the subsoil is of a very sticky nature, due to its relatively high clay content, and the color is generally dark gray. With increase in depth the material generally becomes lighter, both in color and texture, grading into white or gray sand at 40 inches. In the central parts of the area the soil becomes deeper and the subsoil much heavier. Here the soil consists of a heavy clay loam to an average depth of about 24 inches, below which occurs a sticky impervious clayey subsoil, becoming heavier with depth. The color of the latter is generally somewhat lighter than that of the soil, although it contains a high percentage of organic matter. In general the subsoil upon drying breaks up into roughly cubical blocks, resembling in this particular an adobe soil. Where excavations for large drainage ditches have been made the walls remain almost perpendicular and are only slightly affected by erosion.

Underlying the subsoil proper at a depth of about 6 feet is a layer of peat. The layer is about 3 feet thick and is in turn underlain by an impure marl which contains small fragments of shells and some organic matter. This marl extends to an undetermined depth.

The following table shows the average results of mechanical analyses of typical samples of this type of soil:

Mechanical analyses of Clyde loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12971, 13135, 13137	Soil	0.1	6.2	5.6	19.0	4.8	38.8	25.1
13138	Subsoil	.0	2.6	3.8	9.8	5.2	49.5	29.3

Only one area of this type of soil occurs in Newton County. It is found about 10 miles northeast of Morocco and lies almost wholly in the west central part of Colfax Township, a small extension reaching westward into McClellan Township.

The surface of the type is practically level, with only a slight fall toward drainage lines, and, as a result, the natural drainage is very poor and has to be supplemented by artificial drains in order to insure the production of good crops. A large proportion of the area is already reclaimed. All of the area can be economically drained, and large crop yields will be sure to follow the construction of a comprehensive drainage system.

The Clyde loam is of lacustrine origin. Prior to the construction of large drainage outlets for the surplus water the area embraced by this soil probably formed a small lake, and the accumulation of the finer material held in suspension by the waters feeding it has given rise to this peculiarly situated body of heavy soil. During low water or probably after there had been a sufficient filling in of this depression so that only a shallow pond remained, conditions were such as to favor the growth of a heavy vegetation, and through the decay of this vegetation a large amount of organic matter has been added to the soil.

The Clyde loam is very productive, and when properly drained and cultivated produces even larger crops than the Miami black clay loam. It is well adapted to the production of oats, rye, timothy, clover, and bluegrass, and is considered one of the best corn soils in the area, to which crop it is largely devoted. The average yield of corn is variously estimated from 40 to 50 bushels per acre. Forty bushels of oats is given as the average yield per acre, but, as on the Miami black clay loam, the growth of straw is heavy, and the grain often lodges. Rye is grown only in limited areas, yielding from 20 to 25 bushels per acre. Clover and timothy are grown to some extent on this soil, and the yields compare favorably with those produced on the Miami black clay loam. Bluegrass makes a thrifty growth, and is used largely for pasture.

CLYDE FINE SAND.

The Clyde fine sand is the prevailing type in the northern part of the county. The soil consists of a dark-gray to black medium to fine sand, in which the latter grade predominates. The depth varies from 4 to 20 inches, depending upon the depth to which the organic matter extends. Along the boundaries of the type, and especially next to areas of Peat, organic matter is found in larger proportions and in some cases occurs to a depth of more than 3 feet. The presence of this high percentage of organic matter gives the soil a loamy texture, and areas are occasionally referred to locally as "semimuck." As the more central parts of the areas are approached the percentage of organic matter becomes proportionally less and the depth to which it extends decreases, until in some cases it is confined to the upper 5 or 6 inches. From this point the soil gradually passes into the Newton fine sand, in which there is practically no organic matter in the surface soil.

At varying depths, as above mentioned, the soil grades into a subsoil having about the same texture as the soil, but containing a much smaller percentage of organic matter. In areas where the soil extends to a considerable depth the subsoil is generally a dark-gray fine sand, which usually becomes lighter in color as the depth increases. Where the soil extends to a depth of only a few inches the subsoil is generally gray in the upper portions but grades into light-gray and occasionally white or yellow-mottled sand at an average depth of about 15 or 18 inches. In areas where considerable iron is found in the subsoil the color generally has a reddish-yellow or brownish tinge and is occasionally mottled. In other areas, at a depth of about 25 or 30 inches, the subsoil is composed of a brownish-colored Peat in which the vegetable fiber is quite easily distinguished. This peaty layer generally extends to a depth of over 3 feet, although occasionally it is only a few inches in thickness and is in turn underlain by a dark-colored sand in which the amount of organic matter is very large.

The following table shows the average results of mechanical analyses of typical samples of this type:

Mechanical analyses of Clyde fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12973, 13139	Soil	0.0	1.8	10.6	60.0	9.2	12.6	5.8
12974, 13140	Subsoil.....	.0	1.7	12.4	69.1	6.7	5.5	4.6

The Clyde fine sand is found throughout the northern half of the county, occurring practically as one continuous body, although much broken by bodies of other types, extending north from the northern base of the Iroquois moraine to the Kankakee River. The surface is practically level, the elevation seldom varying more than 5 or 6 feet. A few low undulations occur, and in some cases small ponds or swampy depressions are found, but the surface is generally flat.

In general the type possesses poor natural drainage. Considerable difficulty is often experienced in the construction of artificial drainage channels, both on account of the level character of the surface and the filling of the ditches by sand, which underlies the greater part of this territory, and by material washed in from the lateral drainage ditches. This last difficulty can, however, be largely overcome by the construction of culverts across the mouths of the lateral drains, thus preventing the banks from being washed away at these particular points. In some localities it is practicable to turn the drainage waters into existing channels. In the northwestern part of the county the upper end of the Houseworth and Riner ditch is connected to the upper end of a branch of the old Beaver Lake ditch, and here the drainage waters flow in either direction. Lower down from the headings of these ditches the fall becomes greater and the drainage is generally much better. The Clyde fine sand is generally improved by drainage. In fact it is necessary to drain this soil before successful agriculture can be practiced. The cost of constructing a comprehensive drainage system will necessarily be large; but the land, if properly managed, should yield a profitable return on the investment.

The Clyde fine sand represents areas which have been formed by the action of water. While primarily of glacial origin, the sand composing this type has probably been transported by stream currents to its present position from sand areas to the north and east, and deposited while this part of the area formed a lake. As the lake was gradually filled up or drained, conditions became such as to favor the formation of a large amount of organic matter.

The crop value of the Clyde fine sand varies in different parts of the area, depending largely upon the proportion of organic matter present. Areas in which the organic content is small are devoted chiefly to pasture, while those in which the proportion is greater and where the soil is impregnated to greater depths produce the staple crops of the county with a fair degree of success. The average yields are gradually decreasing from year to year, and will continue to do so as the organic matter in the soil is consumed. The yield of corn, which ten or twelve years ago was as high as 50 bushels, is now estimated at from 10 to 30 bushels per acre. The yield of oats, which was formerly much higher, is now on the average about 20 or 30 bushels per acre. Potatoes do well during favorable seasons, but unless the land is well drained the crop is often waterkilled or rots before coming up, during wet seasons. The average yield of this crop is estimated at from 125 to 200 bushels per acre. Some rye is grown, and yields from 10 to 20 bushels. It is generally sown as a nurse crop for timothy, which does very well on the heavier areas, yielding from three-fourths to 1½ tons per acre. Clover is not grown to any extent, inasmuch as it is generally winterkilled. Sugar beets have been successfully grown on this soil, but at present no attention is given to their production. Small fruits do well, and it is considered an ideal soil for strawberries. It is also a fine truck soil, but up to the present time little attention has been paid to this industry. The greater part of this type is devoted to pasturage. The poorly drained areas are generally covered with "sour grass," which is seldom eaten by stock, unless other grasses are short. Near the Miami fine sand areas and occasionally on the low knolls the vegetation consists of a natural growth of different varieties of oak. Bluegrass is generally found growing quite luxuriantly on the better drained areas.

In order to obtain an idea of the manurial requirements of this type a large sample was collected about 2½ miles north of Morocco. The soil in this particular field consists of a black sand, containing a large admixture of organic matter, but so incoherent that when dry it blows and shifts to some extent. The surface is very level, and it holds considerable water despite its porous texture. The field from which the sample was taken has been in cultivation for from fifteen to twenty years. Corn and oats are grown in regular rotation, and form the sole crop interests. Small amounts of stable manure are used, chiefly on the corn, and no other fertilizers. Yields of both corn and oats average about 30 bushels per acre.

The results of the examination of this sample by the wire-basket method indicate that stable manure has a moderate effect in increasing the growth of crops; that nitrate of soda and sulphate of potash give a small increase, and that nitrate of soda, sulphate of potash, acid phosphate, or lime used alone or in combination (except as above), have little or no effect. These results were obtained under favorable climatic conditions for the crop and by having the soil in the best possible physical condition, and, while held to be strictly applicable only to the field from which the sample was taken, they substantiate the general farm practice on this type of soil in Newton County, where considerable barnyard manure is applied to the fields with beneficial results and practically no mineral fertilizers are used.

NEWTON FINE SAND.

The Newton fine sand resembles the type just described to a remarkable degree, the chief difference being in the percentage of organic matter. The organic content is generally very small and in most cases is not sufficient even to color the soil, while in the case of the Clyde fine sand, as we have seen, the organic content is generally large.

The soil of the Newton fine sand, to a depth varying from 10 to 36 inches or more, is composed chiefly of fine sand. Around the outer margin of the areas the soil generally extends to a depth of over 3 feet. The color is a light gray, grading into mottled yellow in the lower depths. Occasionally some organic matter is found in the first 3 or 4 inches, but the amount is generally so small as to have practically no effect upon the soil. In the more central parts of the soil bodies, at a depth varying from 10 to 20 inches, a layer of sand is encountered which contains a high percentage of organic matter, and in some cases this layer consists almost entirely of Peat. The layer varies in thickness, but seldom exceeds 6 inches, and it is not unusual to find two and sometimes three such layers in the subsoil, in which case they are generally much thinner and occur from 6 to 15 inches apart. The subsoil underlying these layers is generally a black fine sand containing considerable organic matter and very similar in character to that underlying the Clyde fine sand.

Along the range line between McClellan and Colfax townships the type occurs in the form of dunes, and the texture of the soil in this case is fine sand to a depth of over 3 feet. It is much finer than the sand composing the level areas, and the color is also much lighter, varying from light gray to white.

The boundary between this type and the Clyde fine sand, as a rule, is difficult to establish, inasmuch as the types grade almost imperceptibly from one into the other. Generally in areas in which the organic matter extends to a depth of over 4 or 5 inches the soil is classified with the Clyde fine sand, while if less it is mapped as Newton fine sand. In some cases, however, the line of demarcation between the two types is sharply defined, being marked by a slight rise of 2 or 3 feet.

The following table gives the average results of mechanical analyses of typical samples of this type:

Mechanical analyses of Newton fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13040, 13151, 13152...	Soil......	0.0	0.8	4.1	87.7	5.5	0.6	0.9
13153...............	Subsoil...	.0	.8	3.3	79.3	9.5	5.0	1.8

The Newton fine sand occupies only a small percentage of the area surveyed, occurring most typically developed in one large area, about 7 miles north of Morocco, in the northeastern part of McClellan Township. Another but much smaller area is found in the north central part of Lake Township, bordering the swamp area along the Kankakee River. The type represents a part of the floor of an old glacial lake. The surface is a few feet below that of the Clyde fine sand, and, while it is generally level, it is broken by numerous ponds and swampy depressions, and occasionally cut by old drainage lines. A number of old beach lines which cross this part of the county from northeast to southwest are quite easily distinguished, and in some cases rise to an elevation of 2 or 3 feet above the general level of the surrounding lands. In the eastern part of the area occurring in McClellan Township, and particularly along the range line between this and Colfax Township, where the dunes already mentioned occur, the area has a desertlike appearance. These dune areas have an elevation of from 3 to 20 feet above the mean surface level of this part of the county.

The natural drainage conditions, as in case of the Clyde fine sand, are poor, and over a greater part of the area the water table seldom exceeds a depth of 3 feet, while at the time this part of the county was surveyed, water was found on the surface over a considerable area.

The Newton fine sand owes its origin to the same agencies as the Clyde fine sand. As evidenced by the layers of peaty deposits, it is quite probable that prior to the deposition of the sand now constituting the surface soil, this territory was only partially submerged at different periods, during which there was a heavy growth of vegetation. Subsequently the water of the lake rose again and completely submerged this territory, and layers of sand were deposited over this vegetation.

None of this soil is at present under cultivation, and its only use is as pasture. It is for the most part covered with water-loving grasses, willow, and birch. The higher and better drained areas are either almost free from vegetation or covered only with a sparse growth of bunch grass. Wherever the native vegetation dies out or is removed the sand drifts badly.

MIAMI FINE SAND.

The Miami fine sand consists of a loose, incoherent medium to fine sand, with a minimum depth of more than 3 feet and a maximum depth of over 100 feet. It varies in color from light brown in the upper portions of the soil to yellow at lower depths, the former color being due to the presence of a very small amount of organic matter, which is found especially in the local depressions between ridges and on some of the more level areas. On the more rolling areas there is practically no organic matter in the soil, and this and the absence of gravel are the chief features distinguishing this type and the Marshall fine sand.

The average results of mechanical analyses of typical samples of this type are given in the following table:

Mechanical analyses of Miami fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12975, 13154, 13155, 13156.	Soil	0.0	2.4	15.5	65.4	10.2	3.2	3.2

The Miami fine sand is distributed over the northern portion of the county. The areas vary from a few acres to over 3 square miles in extent and occur as islandlike bodies in the level sand areas. The surface is very irregular, consisting of rounded hills and ridges, from 2 to more than 150 feet in height. Owing to the physical character of the soil and its rolling topography, natural drainage over most of these areas is excessive, and vegetation often suffers from lack of moisture.

The origin of this soil is largely due to the action of winds, though it is probable that during the early stages of development wave action also played an important part in its formation. On account of the loose, open character of the soil and the unstable or drifting nature of this material it has little agricultural value. It is for the most part covered with a native growth of timber, chiefly scrub white and black oaks, hazel brush, black gum, sumac, and a few quaking aspens. On some of the lower, moister areas bluegrass is found. Only a few areas of the Miami fine sand are farmed. Sorghum is grown to some extent for home use and melons and early potatoes do well. Some rye and corn are produced but the yields are very small. Fruit is grown to some extent and is said to do fairly well.

KASKASKIA LOAM.

The surface soil of the Kaskaskia loam is a brown loam or silty loam, with a depth varying from 18 to 24 inches. The texture of the soil is quite uniform, although it is heavier in some of the depressions farthest from the river than it is on the higher areas or near the present channel. The soil is generally quite friable and readily cultivated.

The subsoil is generally a loam, although some sections exhibit but a slight difference between the soil and subsoil. In most cases, however, the sand content increases with depth. The percentage of organic matter in both the soil and subsoil is less than is usually found in alluvial types. A large amount of iron is usually present, which sometimes gives the subsoil a mottled appearance.

The average results of mechanical analyses of typical samples of this type are given in the following table:

Mechanical analyses of Kaskaskia loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13103, 13105	Soil	0.2	0.7	0.7	9.2	13.9	53.1	22.0
13104, 13106	Subsoil.....	.1	.5	.5	9.1	18.6	51.7	19.4

This type occupies only a limited area along the Iroquois River in the eastern half of the county. It constitutes the flood plain of this stream and is confined to the oxbows and to narrow strips along some of the less crooked parts of the channel. It is seldom more than a few feet above low water and is subject to overflow. Numerous depressions and sloughs occur, which mark the course of former stream channels, having been deposited by the river during high water. The current is here too sluggish to transport any but the finer materials, so that the type is remarkably free from coarse sand and pebbles.

The Kaskaskia loam is largely devoted to pasture. Some of the areas are planted to corn and during favorable seasons yield from 40 to 50 bushels per acre. Oats and potatoes can be successfully grown, though there is always danger from overflow.

SWAMP.

The classification of Swamp is based upon topographic position and drainage conditions rather than upon the physical character of the materials of which it is composed. The texture varies in different parts of the areas from a light sandy soil to a heavy clay loam, though the greater proportion is a black sand, very similar in character to that of the Clyde fine sand. A constant feature is the extremely large admixture of more or less decayed vegetable matter.

With the exception of one small body occurring in the western part of Beaver Township the Swamp is confined to a strip from one-eighth to over 1 mile wide along the Kankakee River, in the extreme northern part of the county. It is low-lying and generally level, though somewhat broken by old stream channels and small lakes, or lagoons, and is poorly drained and under water most of the year. Owing to its slight elevation above the river it can not be drained economically.

The areas are largely the result of poor drainage. Along the river it has been slightly modified by the deposition of fine material brought down during high water. Through the growth of a heavy vegetation a large amount of organic matter has been added.

Except along the streams where there is a heavy growth of timber, chiefly birch, oak, poplar, and willow, the native vegetation consists of a host of moisture-loving plants, such as reeds, rushes, sedges, etc. None of the Swamp is under cultivation. When the river is low some areas become dry enough to allow the cutting of hay, and such areas are also used to some extent for pasturage.

PEAT.

A very important and characteristic feature of the northern part of the county is the frequent occurrence of quite extensive Peat deposits. They consist of brown peaty material, in which the percentage of combustible material is extremely high. In consistency the soil varies from a coarse, raw, fibrous Peat through all stages of decomposition to that of Muck. The Muck areas occur, however, to a limited extent around the outer margins of these deposits. The soil in this case consists of more thoroughly decomposed vegetable mold mixed with varying amounts of mineral matter and extends to a depth seldom exceeding 3 feet. The typical Peat is much deeper, generally extending to a depth of 10 or 12 feet.

The texture of the subsoil varies from a medium to fine sand in which the percentage of organic matter is quite low. It varies in color from dark to light gray, and in some cases is slightly mottled. In a few localities the underlying material is a light-blue or gray clay, while in others it is a marl. Such areas as these are, however, quite limited and occur only as local variations.

The Peat occurs most typically developed northeast of Morocco, in Beaver, McClellan, Colfax, and Lincoln townships. A few small areas occur west and southwest of this town on the Iroquois moraine. The general character of the surface of these tracts is level, with only a slight fall toward drainage lines. Over some areas the surface has a hummocky appearance, due to the presence of small tufts or bunches of grasses and other vegetation. The hummocks seldom exceed 12 inches in height. Large holes and depressions often occur, especially in areas which have been burned.

The Peat has been formed by the gradual accumulation of organic remains in low wet places. During depositions the materials were more or less under water, which has retarded decomposition, and the vegetable fiber in most cases is yet easily distinguished.

The drainage of the areas of Peat is an important problem to the land owners in this section of the county. The areas usually have a fall of from 2 to 5 feet per mile toward the main drainage lines, and while a large amount of water accumulates in the spring, both from the melting of snow and from spring rains, it is practicable to remove this by the construction of wide deep ditches. It is believed that open ditches even for the lateral drains would prove more effective than tile. The little drainage channels in the soil would form more quickly and the excess water would be removed more rapidly. After the land is once thoroughly drained tiling would undoubtedly prove effective. Large tracts of the Peat have been drained, dredges being used to dig the main ditches across the lowest depressions of the areas or along such lines as would give the greatest possible fall. These ditches vary in width from 12 to 15 feet and in depth from 10 to 12 feet. A few laterals have been constructed which are as large as the main channels and into which sublaterals are run, but in most cases the laterals are much smaller and irregularly placed, generally at intervals too great to be effective. A glance at the map accompanying this report will show the main drainage channels of the county as well as of the Peat areas.

The cost of constructing the existing drainage systems has been great, so it is most desirable that immediate returns be secured on the capital invested. In some cases the results obtained from growing crops on the Peat have been most gratifying; in others they have been most discouraging. It has been the experience of most of the farmers that the Peat generally produces fairly well for two or three years after being reclaimed, when its productiveness begins to decline, each succeeding crop being poorer than the one preceding. On the other hand, some of the areas improve with cultivation, although the improvement is gradual. There are also areas that have never produced well, the crops being generally small and frequently failing to mature. It has also been observed that the productiveness of the Peat areas is correlated in some way with the state of the organic matter present and that as soon as the marsh sod, leaves, trash, etc., plowed under, become thoroughly decayed or consumed the yields of the crops grown cease to be profitable.

Corn is most extensively grown upon these soils the first few years. The yields of the first crop or two are quite large, though the corn produced is of poor quality. The kernels do not generally fill well and are often chaffy. The yield and quality of the succeeding crops are generally poorer, the ears are smaller and do not fill well, and the stalks are small. Later crops frequently do not produce any ears, and during the growing season the stalks turn yellow and growth is checked. In some areas the first crop grown is of this character, and spots giving like results occur even in the best areas, where no difference in drainage conditions or other cause can be assigned for the difference in the growth of the plants. A very few farmers have built silos, and thus utilize the inferior products of the Peat, but such a method can hardly be practiced to good advantage except on a dairy farm.

Very frequently this soil produces a rank growth of stalk or straw, as the case may be, in which the grain does not fill out well. Timothy and bluegrass may be grown wherever the drainage is reasonably good, but neither of these grasses is so profitable as corn. Special truck crops will do well on the Peat, but few landowners have either the inclination or experience to attempt their cultivation. This has led to considerable experimental work on these soils with corn, but the results so far obtained have not proven entirely satisfactory, although somewhat larger yields have been produced.

The general conclusion reached is that these and similar soils in Illinois, Wisconsin, and other parts of Indiana are in need of potash,[a] and in some cases potash, phosphoric acid, and stable manure should be applied to make them productive.[b]

The results obtained last season on an experimental plot in the southeast corner of section 35, McClellan Township, under the direction of the Indiana experiment station, show that two plots upon which muriate of potash and sulphate of potash were applied, respectively, produced at the rate of 48.9 bushels and 40.5 bushels per acre. Where no fertilizer was added the yield was 36.4 bushels. Another plot, where 1 ton of coarse straw was applied, produced at the rate of 58.5 bushels per acre, or about 10 bushels more than the plot fertilized with muriate of potash.

It would seem from these results, together with the generally observed fact that these soils produce well until the marsh sod, etc., is destroyed, that the Peat of the area is not lacking in plant food, and that the low yields are due to some unfavorable condition, which was alleviated by the addition of coarse straw. While potash improves these soils it seems quite probable that the beneficial results are not due to the plant food thus added, but to some other effect it has upon the soil.

While this type of soil is less extensive than many in the area, its peculiar condition after a few years' cultivation, as discussed above, made it advisable to select this as one of the types for investigation as to manurial requirements. For the purpose of carrying on this line of work, several samples of the soil were collected from sections 1 and

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[a] Buls. No. 93 and 95, Illinois Exp. Sta.

[b] Twenty-first annual report, Wisconsin Exp. Sta.

2, township 29 north, range 9 west. The soil here consists of brown mucky peat, varying from 30 to 40 inches in depth and usually underlain by sand. Where the samples were taken the water table varied from 2 to 3 feet below the surface.

The results obtained upon this soil by the above-mentioned method indicate that both stable manure and green manure are decidedly beneficial. Sulphate of potash gave a large increase in growth, whereas lime, nitrate of soda, and acid phosphate had little or no effect. These results are in accord with the conclusions of the experiment stations cited above.

When thoroughly reclaimed the Peat should be well adapted to corn, potatoes, onions, celery, cranberries, and similar crops. Owing to the high percentage of nitrogen present it has a particular adaptation to corn, rape, and the grasses. It is an ideal timothy soil, producing from 1 to 1½ tons per acre, and bluegrass does exceedingly well and is used for pasture. The chief difficulties encountered in farming the Peat areas, aside from the conditions already discussed, are wetness in the spring, danger of frost, and the accumulation of excessive amounts of nitrates. Even when well supplied with open drains the soils are often too wet to allow early sowing of crops, and it frequently happens that crops have to be planted two and occasionally three times before a stand is secured. This necessarily so shortens the growing season that there is danger of frost before the crops mature. The excess of nitrates, which tend to stimulate stalk and leaf growth, often causes oats and other grains to lodge badly, and this makes the type in general unsuited to these crops, although under the most favorable conditions they often do well.

AGRICULTURAL METHODS.

The cultural methods generally practiced in the area pertain largely to the production of corn and oats. In the preparation of the soil for corn, which generally follows oats, the land is plowed deep in the fall, generally as soon as the oat crop is removed. Nothing more is done with the soil until spring, when, as early as the season will permit, it is disked and harrowed. The corn is then planted, generally with a check planter, in rows about 3 feet 6 inches apart, later leaving three or four stalks in each hill. Very frequently the ground is harrowed after planting, and, in addition, is cultivated three or four times during the season. Implements with small shovels and other attachments adapted to shallow cultivation are preferred by most of the farmers to those which do deeper work or leave the land in ridges.

The corn is generally planted in May, although corn planted as late as June 10 will yield well, providing the season is favorable. A small part of the crop is cut with binders and subsequently shredded or husked from the shock, but the greater part is gathered from the standing stalks. Since a very few farmers in the southern part of the county feed cattle or have much stock of any kind, the greater part of the corn produced is sold at the nearest elevators. Occasionally some of the corn stover is harvested for feed, but the practice is not general.

In growing oats the seed is generally sown broadcast on land that has been in corn the previous year without any preparation of the soil. The disk is then used to pulverize the surface and cover the seed. The crop is sown as early as the season will permit, and is harvested the latter part of July. The grain is seldom stacked, but is thrashed from the shock soon after it is cut.

In seeding lands to grass and clover it is the general practice to use oats as a nurse crop, but the success of this method depends almost wholly upon climatic conditions. Upon the removal of the nurse crop the young plants are exposed to the hot sun and winds, and growing in a soil already largely exhausted of its moisture, can make but feeble growth unless moisture conditions remain favorable. If these crops become fairly well established they will endure very unfavorable conditions, which frequently occur during the winter months. There is, however, considerable danger of the clover heaving, and this condition is largely responsible for the small acreage of this crop.

Rye is sown in the fall on land that has been in corn during the growing season. The usual date of sowing is about September 20, and of harvesting about July. It is quite generally used in the northern part of the county as a nurse crop for timothy. Timothy in this section is occasionally sown in the fall without a nurse crop, and the first cutting of hay is harvested the following spring.

A large proportion of the soils in the northern part of the county are in pasture or hay. Most of this grass is utilized in cattle feeding, which is conducted on an extensive scale by companies and a few wealthy landowners. Light-weight cattle are purchased on the Chicago markets, shipped in here, and fed for a few months. This method has proven more profitable than raising calves. The cattle feeders purchase all the corn produced in this section of the county, and in addition import a considerable quantity of cotton-seed meal for feeding purposes.

Aside from the use of stable manure and the occasional plowing under of a green manure crop, the soils of the area receive practically no fertilizers. A few farmers in the east-central part of the county and a few of those farming areas of Peat buy some commercial fertilizers, but as a rule the quantity used is very small.

No systematic rotation of crops is practiced in the area. The general system followed is to plant corn one year and sow to oats the following year, then back to corn again. In some cases the farmers do not alternate corn and oats from year to year, but plant to one crop, generally corn, for a period of years. Occasionally a clover crop is grown and plowed under for green manure. It is generally recognized that this crop will keep up the fertility of the soils if not sown at too great intervals. The growing of this crop for green manuring should be encouraged wherever it is possible to secure a fair stand, and it should be introduced into the rotation once every three or four years at least.

Under the present system of farming the soils have decreased in productivity and are gradually becoming poorer from year to year. Land which formerly produced 60 or 70 bushels of corn is now producing 30 or 40 bushels per acre. And it is not exceptional to find even lower yields if climatic conditions have been unfavorable.

This matter is of great importance to the landowners of the area, and the necessity of methods less exhaustive to the soils is generally recognized. The trouble can easily be obviated by a proper system of farm management, which should be installed before the lands become poorer in crop-producing power. More stock should be raised to consume all the products of the farm and make more manure to be applied to the lands, a systematic rotation of crops should be practiced, and leguminous crops should be raised to supply nitrogen and increase the organic content of the soil. If this were practiced, the soils would not only at once produce better crops than can be grown at present, but they would gradually increase in productivity from year to year.

AGRICULTURAL CONDITIONS.

The resources of Newton County are almost wholly agricultural. The soils, although not as productive as formerly, give good yields, and from the general appearance of the country the farming class is in prosperous circumstances. During the last decade the price of land has steadily advanced. The valuation of all farm lands, according to the State assessor's report for 1904, is $5,396,360, while that of buildings is placed at $705,180. These figures represent less than 40 per cent of the actual value of the farms of the county.

Very few farmers are in debt, and in 1903 there were only 80 farm mortgages on record. The farm houses, especially upon farms operated by the owners, are well built, and in many cases are handsome residences. The barns are large, substantially built, and painted, while the other outbuildings are usually well kept. Most of the lands are inclosed by fences or hedges, wire and osage orange being most commonly used.

More than one-half of the farms of the area are operated by tenants who are usually compelled by the lease to grow certain specified crops. The larger estates are generally divided up into a number of farms which are rented. These estates are usually looked after by a manager or foreman, whose duty it is to supervise the work of the different farms and to see that the terms of the leases are carried out.

The usual rent for good land varies from two-fifths to one-half of the grain delivered at the nearest elevator, and when a cash rent is asked from $3.50 to $5 an acre for pasture and hay lands. In a few cases renters have to pay house rent, which is often as high as $50 a year. On the larger estates, especially on those where stock is raised, the usual rent is two-fifths of the crop delivered at the home place. In some cases the landowners have the tenants feed cattle for them, buying the tenant's share of the crops for feeding purposes and paying him from $30 to $50 a month for feeding and caring for the stock.

Most of the farms are the property of men who have moved to the towns, and there are also a good many which represent investments or inheritances.

There are four estates in the county which have more than 5,000 acres under one management, and a number of others which include more than 3,000 acres. Small farms of 20 or 40 acres are comparatively few, and the greater number vary in size from 160 to 240 acres.

The value of the land depends almost altogether upon the drainage conditions and the character of the soil. The Marshall loam and Marshall fine sandy loam have the highest value, frequently selling for $125 an acre. The Clyde fine sand and Clyde loam sell for about $50, while the Miami fine sand and Newton fine sand are worth much less. Poorly drained areas of Swamp and other soils, used mostly for pasture, vary greatly in price, but seldom exceed $25 or $35 an acre.

There is no particular scarcity of farm labor in the county, but many farmers complain of the difficulty of securing permanent help, inasmuch as few young men seek farm employment except as a temporary occupation. The usual wages are about $25 a month, with board. Day labor, especially during harvest, commands $2 or more a day.

The principal products are limited in variety, but there is considerable difference in their quality. The best corn, grown on the Marshall loam and Marshall fine sandy loam, is usually graded as "No. 3" on the Chicago market, but that grown on the more sandy soils is much inferior in weight and feeding value. A similar difference is observed in the oat crop, but very often the quality of the best grain is materially reduced by being thrashed from the shock instead of from the stack after being allowed "to go through the sweat."

In 1904 this county produced 2,247,965 bushels of corn and 1,462,269 bushels of oats. The land devoted to these two crops was 119,630 acres. The total acreage of clover for the same year was 1,748, while that devoted to timothy was about 12,000 acres. The production of wild grass on the poorly drained lands is a very important item. The quality is rather poor, but the native varieties are gradually giving place to bluegrass, wherever the water table is permanently lowered.

The live-stock interests are confined chiefly to the feeding of cattle on the cheaper lands of the northern part of the county. There are very few farmers who do not have two or more milch cows and fatten a number of hogs each year, but the income from these sources is far less than the county is easily capable of producing. A large number of excellent draft horses are raised, which usually bring a good price on the market. At the present time the price of horses is high, good draft types selling for $150 to $200, and a good team, well mated, bringing from $300 to $400. In only a few cases is special attention given to the production of any kind of high-grade live stock.

The fact does not seem to be generally recognized that the soils of the area are adapted to a wider diversity of crops than is at present grown upon them. Neither is the fact appreciated that certain crops are grown upon soils which are unsuited to them, and that the poor yields almost invariably secured are not so much due to the natural unproductiveness of the soil as it is to the fact that the soil is not adapted to their production.

The Marshall loam is well adapted to corn and oats. Timothy and clover can be raised on this type, but the climatic conditions are generally such as to make the production of these crops uncertain. Barley, flax, and millet have been produced on this soil type in other areas, but the success of growing these crops in this county would depend largely upon climatic conditions. The same can be said of the Marshall fine sandy loam and the Clyde loam, but in addition wheat can be grown upon the former under suitable conditions. The Miami black clay loam is generally recognized as a corn and grass soil. Clover will also do well on this type, particularly on the better drained areas.

Corn and oats are also grown upon the level sandy soils of the northern part of the county, but these soils are not well adapted to these crops and the yields are generally very poor. Hay and rye are grown on these soils, but the yields are generally light except on areas in which the soil contains large amounts of organic matter. These sandy soils are particularly well adapted to small fruits and truck crops. Wherever drainage conditions are favorable the Clyde fine sand offers exceptional advantages for small fruit and truck growing. Newton fine sand probably offers the same advantages, but a large amount of organic matter must first be incorporated in this soil to make it produce well. A few farmers have already engaged in the small fruit and truck business with encouraging results.

Locations may be selected where grapes, plums, and pears will do well. A fruit farm in the Clyde fine sand has averaged during the last two years over 3,000 quarts of strawberries per acre under ordinary field conditions, and large yields of early potatoes, cabbage, and other vegetables have also been reported.

The sandy soils of the area are also well adapted to pasture, and a large percentage of them in the northern part of the county is devoted to grazing. The Miami fine sand areas have at present little agricultural value, but they can be made to produce successfully such crops as small fruits, early potatoes, and truck.

While there are no large towns within the borders of the county, transportation facilities to Chicago and other cities east and west are very good. There are three railway lines direct to Chicago, which is about 80 miles distant. In addition to the small towns, there are a number of grain elevators located along the railroads, so that the farmers have only a short distance to haul the grain to a shipping point. The public roads are generally kept in good repair, and many miles of these have been covered with gravel or crushed stone.

SOIL SURVEY OF TIPPECANOE COUNTY, INDIANA.

By N. P. NEILL and W. E. THARP.

LOCATION AND BOUNDARIES OF THE AREA.

Tippecanoe County is situated in the west central part of Indiana. It is bounded on the north by White and Carroll counties; on the east by Carroll and Clinton counties; on the south by Montgomery County, and on the west by Fountain, Warren, and Benton counties. The county comprises approximately 320,000 acres, or 500 square miles.

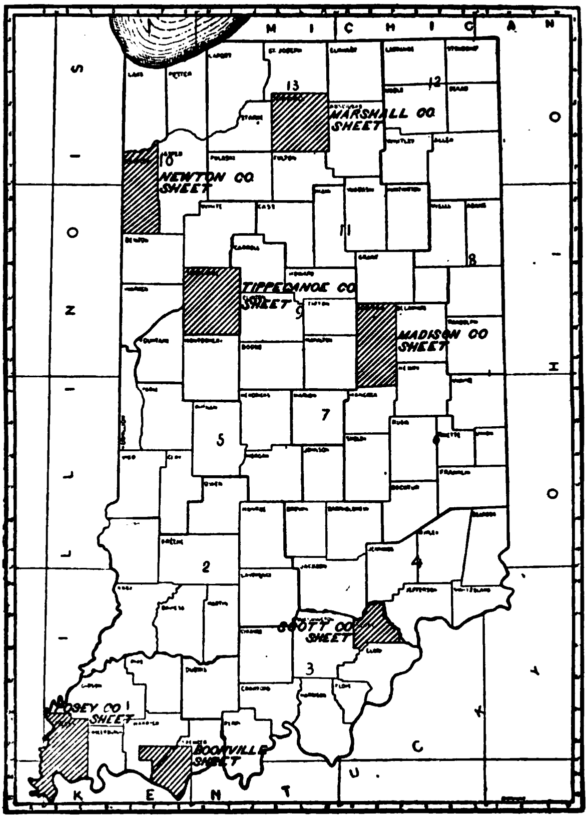

FIG. 33.—Sketch map showing location of the Tippecanoe County area, Indiana.

It is nearly square in shape, its width east and west being 21 miles and its length north and south about 24 miles. Lafayette, the county seat, which is quite centrally located, is the principal town and has a population of about 20,000. Purdue University and the Indiana State experiment station are located at this place.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

A little over three-quarters of a century ago Tippecanoe County was inhabited by hostile Indian tribes belonging to the great Algonquian family. The defeat of the Indians in 1811 by General Harrison at the battle of Tippecanoe broke their power and rendered the country available for settlement. By an act of the general assembly of the State of Indiana Tippecanoe County was formed out of Wabash County in 1826, the latter then embracing all of the territory lying north of Montgomery County as far as Lake Michigan. Lafayette was chosen as the county seat.

In the latter part of 1822 or early in 1823 Peter Weaver settled in the lower end of Wea Plains, on the south side of the Wabash River. Other pioneers settled around him, and early settlements were also made near Clarks Point, in the neighborhood of Westpoint and on Little Wea Creek. The early settlers came principally from eastern and southern Indiana, the majority of them being natives of Ohio, Virginia, Kentucky, and Pennsylvania. In later years, as the county became better developed, immigrants came from Illinois, New York, Maryland, and West Virginia.

In taking up the new land the settlers generally selected timbered areas. The open prairie lands, which were considered poor and unproductive, were swampy and poorly drained, and were covered with a tough, thick sod which could not be broken with the tools possessed by the settlers. The timbered areas, when cleared of their forest growth, offered little resistance to cultivation and possessed good natural drainage. In course of time, when newcomers were unable to locate claims, except on the prairie lands, a heavy sod plow was invented with which the tough sod could be broken. While it was a crude, poorly constructed implement, requiring several yoke of oxen to draw it, it nevertheless served its purpose, and the farmers were well repaid for the labor expended in breaking up the prairie soils. They were found to be more productive than the timbered areas, yielding larger and better crops on the well-drained areas.

Corn and potatoes were the first crops planted on the newly cleared timbered lands, while corn was generally the first crop grown on the virgin prairie soils. In planting corn on the prairie soils it was the practice the first year to drop the grain in the furrow as the sod was being turned under. This was called "sod corn" and was not worked during the growing season, it being impossible to cultivate the crop without tearing up the sod and pulling out considerable of the corn. The corn thus produced was generally of poor quality. In the fall the land was plowed and put in wheat, which was sown broadcast. Wheat was generally the second crop grown on the new soil, but in some cases corn was grown for two or three years before the land was sown to wheat. The wheat was at first cut with a sickle and later the cradle came into use. It was either thrashed out with a flail or spread on the barn floor and trampled by horses until the grain was separated from the straw. Reapers and thrashing machines did not come into use until some time during the sixties. The early settlers also raised some flax and wool, from which they made their clothing.

Little progress was made in agriculture prior to the completion of the Erie and Wabash Canal in 1840. Most of the grain produced had to be consumed at home. Occasionally a load of grain or other produce would be taken west to Chicago or east to Louisville or Cincinnati and salt and other provisions brought back. It took several weeks to make the trip, and only small loads could be hauled, because of the bad roads. Produce of all kinds was very cheap at this time. Some traffic between Lafayette and other small cities to the south and east was carried on by steamboats and other smaller craft on the Wabash River. While navigation of this character figured quite extensively in the earlier growth of the county, it was not until the completion of the Erie and Wabash Canal, which furnished direct communication with the Ohio River, that more rapid progress was made in the agricultural development of the county. With these increased shipping facilities produce of all kinds could be sent to the south and east, where it was more in demand and brought higher prices.

Following the introduction of canal navigation the county began to develop rapidly. Large areas of timber lands were cleared and put under cultivation. Soon afterwards large tracts of prairie land were broken and converted into productive fields. Many improvements rapidly followed. The settlers began draining their land, open drains being most commonly used. A great deal of fencing was done, Osage orange hedges being used generally. In later years these hedge fences have been largely replaced by wire.

Late in the fifties the first railroad was built in the county and aided greatly in its development. Other railroads were soon afterwards constructed, and as they afforded better and more rapid transportation facilities they secured most of the shipping trade, finally forcing the abandonment of both the canal and the river as means of transportation.

CLIMATE.

There are no marked peculiarities in the climatic conditions of the area. The climate is humid and is about the same as that of the Middle States lying in the same latitude. Extreme temperatures seldom occur during either the summer or winter months, and the rainfall is well distributed throughout the year. The following table, compiled from the records of the Weather Bureau station at Lafayette, shows the normal monthly and annual temperature and precipitation:

Normal monthly and annual temperature and precipitation.

Month.	Lafayette.		Month.	Lafayette.	
	Temperature.	Precipitation.		Temperature.	Precipitation.
	°*F.*	*Inches.*		°*F.*	*Inches.*
January	25.1	2.19	August	72.7	3.16
February	27.7	2.78	September	65.9	2.66
March	36.9	3.01	October	53.0	2.45
April	51.0	3.20	November	38.9	3.24
May	61.2	4.59	December	30.1	2.49
June	71.2	4.50	Total	50.7	37.79
July	74.8	3.52			

As appears from the foregoing table, the average annual precipitation is about 38 inches. The greatest amount of rainfall occurs during May, June, and July, and the lowest precipitation comes during the month of January. The average annual temperature is about 51° F. The growing season comprises about six months of the year, during which time crops are safe from frosts. It is seldom that crops are injured by frosts on the uplands, but occasionally those grown on the bottoms are injured if sown late in the spring.

The following table shows the dates of first and last killing frosts for the past seven years:

Dates of first and last killing frosts.

Year.	Lafayette.		Year.	Lafayette.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1898	Apr. 6	Oct. 15	1902	Apr. 5	Sept. 14
1899	Apr. 16	Sept. 27	1903	May 1	Sept. 18
1900	May 10	Oct. 17	1904	Apr. 21	Oct. 23
1901	Apr. 21	Oct. 5	Average	Apr. 20	Oct. 4

PHYSIOGRAPHY AND GEOLOGY.

Tippecanoe County lies wholly within the drainage basin of the Wabash. North of this river the general fall is toward the south, while south of it the fall is toward the north and west. The smaller streams flowing into the Wabash have cut channels from 10 to over 175 feet deep, which as a rule carry off the surface water quickly and afford excellent outlets for artificial drains. The Wabash River enters the county at the northeast corner, flows in a general southwesterly direction, and leaves the county about the center of the western boundary line.

The Tippecanoe River enters the area about 4 miles west of the northeast corner, flows in a southerly direction, and empties into the Wabash about 3 miles south of the northern boundary line. This stream drains only a small proportion of the northeastern part of the county. Pine Creek, Indian Creek, Burnett Creek, and their tributaries drain that part of the county north and west of the Wabash River, the eastern half of the area south of the Wabash is drained by Sugar Creek, Buck Creek, and Wildcat Creek and its tributaries, while the southwestern section of the area is drained by Big and Little Wea creeks and Flint Creek.

The general altitude of Tippecanoe County is about 750 feet above sea level. The high bluff lines about 4 miles north of Lafayette and the uplands between Wildcat and Sugar creeks have an elevation of a little over 800 feet. It is quite probable that these are the highest points in the area.[a]

Along the margin of the Wabash River and its principal tributaries the surface is generally broken and hilly, while back from these streams the topography of the county is slightly undulating and rolling, gradually extending into plains or level tracts. In the northwestern part the surface varies from level to slightly undulating, but eastward the surface becomes more or less undulating and rolling in character, and in the northeastern part, where Burnett Creek, the Tippecanoe River, and the Wabash River approach one another, it is quite uneven and somewhat broken. That part of the uplands east of Tippecanoe River and north of the Wabash is level or only slightly rolling.

In the western part of the county, north of the Wabash River and extending east to Lafayette, the surface is slightly undulating. Pine Creek has formed only a small, shallow valley in this section, but near the margins of the valley formed by Indian Creek, particularly along the southern half of its course, the surface is more or less broken. The valley formed by this stream is narrow and is marked by rather steep bluff lines.

The valley of the Wabash is quite narrow, considering the size of the stream. The valley floor varies in width from a few rods near Lafayette to perhaps a mile at other points and is generally marked by prominent bluff lines. In some cases the bluffs have been worn into well-rounded contours or gently sloping descents, while in other cases, particularly near Lafayette and in the northeastern part of the county, they are precipitous and from 50 to 100 feet or more above the level of the valley floor. The surface of the low bottoms of the Wabash varies but little along its course, and its height above the low-water mark is between 10 and 20 feet. These bottoms are subject to overflow during periods of high water.

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[a] Fifteenth Report, Indiana State Geologist.

West of Lafayette, on the south side of the river, a second terrace is developed. This has an elevation of from 40 to 80 feet above the bottom lands and extends back from 2 to 5 miles from the river. This comparatively level tract, known as Wea Plains, was originally a prairie, and is composed of a mass of sand and gravel from 125 to 200 feet in depth, covered by a mantle of soil of varying thickness.

South of Wea Plains the surface becomes more rolling and is crossed by a number of ridges of varying height which have a general trend from east to west.

On the opposite side of the river from Wea Plains a gravelly terrace is developed, with about the same elevation as the plains. This is really a third terrace, as a lower or second terrace occurs from 25 to 30 feet above the bottoms. About 4 miles below Lafayette this second terrace is well developed, but it gradually merges into the higher or third terrace as the city is approached. This second terrace varies in width from a few rods to over 1 mile.

The surface of the uplands of the eastern half of the county south of the Wabash River varies from level to slightly rolling. Near the stream courses the surface becomes more or less broken and hilly. The valley formed by Wildcat Creek is marked by steep, precipitous bluffs ranging in height from 50 to 100 feet or more. The bluff lines are most prominently developed near the point where the South Fork enters the main stream, but as the source of the stream is approached the bluff lines become more rounded and possess more gentle slopes. The bluffs along the South Fork are not so prominently developed. The valleys formed by these streams are narrow and the surface irregular, being broken by low hills and ridges, old stream channels, sloughs, and swampy depressions. Second bottoms, generally quite narrow, are developed along certain parts of these stream courses.

North of Wildcat Creek the uplands are broken by the deep, narrow valleys formed by Buck and Sugar creeks.

The entire region is covered with glacial débris, the thickness of which varies greatly in different parts of the county. The greatest depth of this drift, so far as is known, is about 150 feet, but it is thought that careful measurements in some parts of the county would show it to be deeper, possibly from 200 to 250 feet.[a]

Prior to the deposition of the glacial material a great depression or basin was formed in the central part of the county by erosion. Immediately following this period of erosion the basin was filled with glacial drift. Subsequent to the deposition of the glacial material a large proportion of the county was covered with loess. The loess varies in thickness from a few inches to 3 feet or more and has resulted in the formation of the most extensive soil types in the area. Generally a few feet below the surface the soils grade into bowlder till consisting of clay, sand, and gravel mingled together in varying proportions. In some cases the underlying material consists of yellow or blue clay, which extends to an undetermined depth, while in other cases it consists chiefly of sand and gravel.

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[a] Fifteenth Report, Indiana State Geologist.

SOILS.

Seventeen soil types were recognized and mapped in the area surveyed. Of these, 8 occur as upland types, 5 as alluvial or river bottom types, and 4 as second bottom or terrace types. The various soils are quite distinct in their typical formations, each possessing its own physical peculiarities. Although each soil type is easily recognized when typically developed, yet in some parts of the county the transition from one to the other is often so gradual that it is difficult to draw accurate boundaries between them. This is especially so in the case of the lighter areas of the Marshall silt loam and the darker areas of the Miami silt loam, and also of the Marshall loam and the Marshall silt loam. Although frequently occurring in limited areas, the bottom land types are generally quite easily distinguished.

The following table shows the extent of the different types of soil found in Tippecanoe County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall silt loam	140,166	43.9	Wabash sandy loam	2,624	.8
Marshall loam	72,320	22.6	Miami loam	1,920	.6
Miami silt loam	44,288	13.9	Muck	1,664	.5
Wabash fine sandy loam	11,712	3.7	Miami gravelly sandy loam	1,024	.3
Marshall fine sandy loam	11,584	3.6	Sioux loam	896	.3
Wabash silt loam	9,408	2.9	Riverwash	832	.2
Sioux sandy loam	9,216	2.8	Sioux silt loam	570	.2
Miami fine sandy loam	4,608	1.6			
Miami black clay loam	3,840	1.2	Total	319,488	....
Miami fine sand	2,816	.9			

MARSHALL SILT LOAM.

The Marshall silt loam is the most important and extensive soil found in the area. It consists generally of a dark-brown to almost black silt loam in which the percentage of silt is extremely high. In some cases the color is much lighter, varying from light brown to dark gray. On the more rolling areas the depth of the soil is about 12 inches, while on the more level tracts and in some of the shallow depressions it is much deeper, occasionally extending to 20 inches. Over the prairie regions occupied by this type the depth is fairly uniform, averaging from 16 to 18 inches. The percentage of organic matter in the soil is generally quite large, giving the type its prevailingly dark color. The color of the soil generally becomes much lighter with depth. As the depth increases the soil gradually becomes heavier, and below 16 or 18 inches it grades into a heavy silt loam subsoil having some of the properties of a clay. This material generally extends to a depth of 3 or 4 feet, but in some cases it grades into a clay loam or clay at a depth of from 28 to 30 inches. Sometimes this clay loam subsoil lies directly beneath the soil. The color of the subsoil is yellow, sometimes slightly mottled or streaked with red or yellow iron stains in the lower sections. Generally below 3 or 4 feet the subsoil consists of a yellow sticky sandy clay, which grades into bowlder till at lower depths. As the Wabash River is approached the underlying material contains more sand and gravel, and near this stream it is composed largely of coarse sand and gravel more or less stratified. An occasional bowlder or small pebble occurs on the surface, particularly upon the morainic ridges.

The following table shows the results of mechanical analyses of a typical sample of Marshall silt loam:

Mechanical analyses of Marshall silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13991	Soil	0.2	1.1	1.3	3.9	5.7	67.2	20.0
13992	Subsoil	.3	.9	1.1	2.9	4.5	64.8	25.6

The Marshall silt loam is most typically developed southeast of Lafayette, and is the chief type, occupying the uplands on both sides of the Wabash River. The type occurs in every part of the county, but is not extensively developed north of township line 24 north, nor is it found to any great extent in the southwestern part of the area.

The surface of the greater part of this type is level, although in certain localities it is slightly undulating and rolling. Near the streams and along the morainic ridges which cross the county in a general east and west direction the surface is somewhat broken. The topographic features of the greater part of this type afford good natural drainage. In the swales and local depressions and over some parts of the more level areas the natural drainage is poor, and artificial drainage is necessary to successful crop production.

This soil has been formed by the deposition of loess over glacial drift. To this have been added large quantities of organic matter from the growth and decay of grasses and other prairie vegetation. The type embraces a part of the typical prairie lands of the county. Some areas, however, especially near the streams, were originally timbered, the forest growth consisting chiefly of oak, ash, walnut, hickory, and maple.

Corn, oats, wheat, and clover are the principal crops produced on this soil. Of these corn is by far the most important. The crop yields vary with the seasons and methods of cultivation, but are always larger than those secured on typical areas of the Miami silt loam. On the well-managed farms corn yields from 50 to 60 bushels per acre, but the average for the type will probably not exceed 40 bushels. The average yield of oats is estimated at 50 bushels and of wheat from 20 to 30 bushels per acre. Clover when cut for hay will average about 2 tons per acre, and when cut for seed from 1 to 1½ bushels per acre. The Marshall silt loam is well adapted to the crops at present grown upon it. It is generally recognized that wheat does better on the lighter than on the heavier phases of this soil. The best results from corn are generally secured on the heavier and darker-colored areas.

In order to study the manurial requirements of this soil, a large sample was collected from the southeast corner of sec. 22, T. 23 N., R. 4 W., and an examination made by the paraffined wire-pot method. The soil at this place is a black or dark-brown silt loam, containing a large percentage of organic matter.

The land from which the sample was taken was originally timbered, but has been under cultivation for the last thirty years. During the last seven years it has been cropped continuously to corn, the average yield being about 45 bushels per acre. It has never been sown to clover, neither have fertilizers of any kind ever been applied. Of the various fertilizer ingredients applied to this soil, none produced any appreciable increase in the growth of the plants. The plants grown on the untreated soil were of good size, thus indicating that thorough cultivation rather than fertilizers is needed on this soil.

In these tests wheat plants were used as an indicator, and the results are held to be applicable only to this crop and to the particular field from which the sample was taken, but in a general way they are believed to apply to a large part of this soil throughout the area, and in this agree with the common farm practice.

MIAMI SILT LOAM.

The soil of the Miami silt loam consists of a light-brown or dark-gray to almost white silt loam with an average depth of about 16 inches. In some localities it is streaked with red or yellow iron stains. Iron concretions are frequently found on the surface and through the soil, and in a few cases some small gravel is found, but the amount is too small to have any appreciable effect upon the texture or agricultural value of the soil. The soil has a loose, flour-like feel, and the amount of organic matter it contains is generally very small. On the ridges and slopes of the bluffs the soil is somewhat more sandy than in the typically developed areas.

There is no sharp line of demarcation between the soil and subsoil. At a depth of 16 inches the soil generally grades into a heavy silt loam subsoil, which gradually becomes heavier with depth. The color varies from gray to yellow and is often streaked with red and yellow iron stains. Below 30 inches the subsoil generally grades into a yellow clay loam, which extends to a depth of 3 or 4 feet. Below this the underlying material consists of a sandy silt or clay, in which the percentage of sand increases with depth. This material is underlain by bowlder till, consisting of clay, sand, and gravel in varying proportions, but in some localities, especially near the Wabash River and a few of its principal tributaries, this underlying material is composed largely of sand and gravel. Over that portion of the type underlain by sand and gravel the soil grades at a depth of about 18 inches into a yellow or mottled yellow, sticky, sandy clay in which the percentage of coarse sand and fine gravel increases with depth, grading eventually into sand and gravel.

This soil type resembles the Marshall silt loam to a marked degree in texture, but is easily distinguished from that type by its lighter color, more hilly surface, and lower crop value. The following table gives the result of the mechanical analyses of a typical sample of this soil type:

Mechanical analyses of Miami silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14003............	Soil.........	0.4	1.8	1.0	2.2	7.3	68.4	18.9
14004............	Subsoil.....	Trace.	.9	.7	1.6	6.5	73.6	16.2

The Miami silt loam is most typically developed over a portion of the uplands bordering the valleys formed by the Wabash River and its principal tributaries. It occupies the best-drained areas of the county. It is found in a long, narrow strip north and west of the Wabash River, widening out into broader areas along the lower courses of Indian and Burnett creeks. Another large area occurs east of the Wabash, from Wildcat Creek northeast to the county line. Between the Middle and North forks of Wildcat Creek is a third area of Miami silt loam. The only other area of any considerable size lies in the southwestern part of the county, in the vicinity of Flint Creek.

A few areas of this type are level, but the greater proportion is rolling, and near the streams it is quite hilly. In many places deep V-shaped gullies have been cut in the steeper slopes by erosion. Owing to the rolling and hilly topography, which characterizes the most of this type, the rainfall runs off readily, and artificial drainage is seldom necessary. The more level tracts, however, could be improved by tile drains.

This type owes its origin to the deposition of loess over glacial material. Because of the good natural drainage, the moisture conditions have been unfavorable to the growth and preservation of a heavy vegetation, and as a consequence a soil has been formed in which the amount of organic matter is extremely low. For this reason the type is less loamy and less productive than other soils of the area in which considerable organic matter has been incorporated through the growth and decay of grasses and other vegetation. This type embraces the greater part of the original timbered areas of the county, and at present considerable timber, consisting chiefly of oak, ash, hickory, walnut, and maple, is found growing upon it, especially in the more hilly and nonagricultural sections.

The Miami silt loam is devoted to about the same crops as the Marshall silt loam, but the yields are generally much smaller. The yields are largest during wet seasons, as the crops grown on the more rolling and hilly areas are frequently injured by drought. Corn and oats average from 35 to 40 bushels per acre, wheat from 15 to 20 bushels, and clover from three-fourths to 1 ton. This soil type is not well adapted to corn, although a considerable proportion of the cultivable tracts is devoted to this crop. Oats do fairly well, and moderate yields of wheat and clover are secured. It is an excellent soil for pasture, and a large proportion of the type, particularly in the hilly sections, is used for this purpose. Some fruit is grown, chiefly apples, pears, and peaches, but the yields are generally light and the fruit is not of the best quality.

The manurial requirements of this soil were studied, using a large sample collected near the center of sec. 23, T. 23 N., R. 3 W. The field from which the sample was taken has been in cultivation for about twenty years, having been planted to corn a larger part of the time, and although no manure or fertilizer of any kind has been used the average yield has been about 30 or 35 bushels per acre.

The results obtained with plants grown in wire baskets indicate that an excellent increase in productiveness may be obtained by the use of stable manure; that nitrate of soda with either sulphate of potash or acid phosphate will give a large increase, and that cowpeas and lime, acid phosphate alone, or nitrate of soda alone will give a fair increase. Sulphate of potash or lime gave only a small increase.

In these tests wheat plants were used as an indicator, and the results are not held to be applicable to other and unrelated crops or to fields which have received treatments essentially different from that from which the sample was taken.

MIAMI BLACK CLAY LOAM.

The Miami black clay loam is the heaviest soil type in the county. The soil consists of a heavy loam or clay loam with an average depth of about 14 inches, the depth varying in different parts of the same area, generally being deeper near the center of the area than near its outer margins. The soil contains a very high percentage of organic matter, and to this is due the characteristic black or dark-brown color. As the depth of the soil increases the percentage of organic matter proportionately decreases, and the color becomes much lighter, generally becoming bluish or grayish at from 10 to 20 inches below the surface. The soil is very cohesive, with a tendency to puddle, and if stirred when too wet or too dry it breaks up into large clods which are difficult to pulverize. If allowed to dry without cultivating, it cracks badly, often forming cracks 1 or 2 inches wide and several inches deep.

The soil gradually becomes heavier with depth, and below 14 or 16 inches grades into a silty clay, the clay content increasing with depth. Below 20 or 24 inches the subsoil generally consists of a heavy, tenacious, impervious silty clay. The color of the upper section of the subsoil varies from light to dark gray, depending upon the depth to which the organic matter extends. It rapidly becomes lighter with depth, finally grading into light-gray or mottled yellow.

While the surface soil is fairly uniform throughout the area, the subsoil varies somewhat in different parts of the county, especially where the type occurs along stream courses. In such localities the subsoil consists of a yellow heavy silty clay grading at a depth of about 30 inches into a heavy sandy clay containing some fine gravel. Occasionally some fine gravel is found on the surface, but the amount is generally small.

The following table gives the results of mechanical analyses of this type of soil:

Mechanical analyses of Miami black clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13600............	Soil.........	0.3	1.3	1.9	5.1	6.2	59.1	25.3
13601............	Subsoil.....	.1	1.1	.5	1.9	5.1	71.1	19.7

The Miami black clay loam occupies only a small proportion of the area surveyed. It occurs as small isolated bodies over the county, and is found most typically developed south and east of Lafayette. It occupies shallow, basinlike depressions on the uplands and is occasionally found along some of the smaller streams. The soil has resulted from the washing of the finer material from the higher levels into these poorly drained depressions, where through the growth and decay of rank grasses and other kinds of vegetation much organic

matter has accumulated. The surface
a slight fall toward the main draina
slightly broken by old sloughs and swa
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sary over all this type, except in the
streams. Some of these lands have
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The Miami black clay loam is one of
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is sometimes allowed to ripen and is
being the average yield. Trouble is f
ing this crop on account of its heaving
of the soil. This can be largely overco
of drainage.

MARSHALL LC

The surface soil of the Marshall loam,
of a black or dark-brown loam with an
Below this the soil grades into a sc
lighter-colored loam, which extends to
The soil contains a small amount of sa
the surface after beating rains. The t
of a loamy appearance, when examin
characteristics of a silt loam, and in sc
rate this type from the darker-colore
matter occurs in this soil in large qu
prevailing dark-brown or black colo
increases the percentage of organic m
becomes correspondingly lighter.

The depth of the soil varies conside
area, depending largely upon the top
the type. On the crest of the low kn
to 10 inches and is generally more sa
the more level areas and in the local
much deeper, averaging 16 or 18 inche
of the soil in these areas is generally
uneven or elevated areas, and the text

The line of separation between the soil and subsoil is generally well defined. At a depth of from 14 to 16 inches the soil grades into a yellow clay loam subsoil, in which the percentage of clay increases with depth. In some sections the clay loam extends to a depth of over 36 inches, but generally at about 24 inches the subsoil grades into a yellow heavy sandy clay. In some cases a depth of 30 or 33 inches is reached before this coarse sandy material appears. Below these depths, however, the subsoil becomes lighter, the sand content increasing, and below 36 to 40 inches the subsoil is a light sandy clay. Occasionally at a depth of 36 inches a thin layer of medium to coarse sand is encountered. The type is underlain by bowlder till. A small amount of gravel and a few large bowlders occur on the surface. In some areas the bowlders are so plentiful as to interfere with cultivation, but in most cases they have been removed from the fields.

The average results of mechanical analyses of typical samples of this soil are shown in the following table:

Mechanical analyses of Marshall loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13594, 13979.......	Soil.........	0.2	1.2	1.1	3.4	7.1	66.2	20.5
13595, 13980.......	Subsoil	.2	1.0	.8	1.9	4.4	70.0	21.5

The Marshall loam occupies a part of the prairie lands of the county. It occurs as a large, irregular-shaped area in the northwestern corner of the county, extending eastward along the northern boundary line nearly three-fourths the width of the area. A second large area is found between Flint Creek and the Wabash River, northeast of Westpoint. In the southwestern part of the county are other large areas of Marshall loam. A smaller area of this soil occurs in the southeastern corner of the county, near Clarkshill.

The surface of the Marshall loam is nearly level or only slightly undulating. The surface is sometimes broken by small, shallow valleys, formed by streams flowing across the type and by a number of low sand and sandy loam ridges, which seldom exceed an elevation of more than 6 or 8 feet above the level of the surrounding country. Owing to the practically level surface of the greater part of this type, the natural drainage is poor and artificial drainage has to be employed in order to insure good crops. When this land was first put under cultivation open drains were mostly used, but in later years these have been largely replaced by tile drains.

The Marshall loam is of glacial origin. Directly associated with the type are large massive bowlders, consisting chiefly of granite, which are found most abundantly in the southern part of the county. In addition to the material deposited by glaciers, there has been added to the soil a large quantity of organic matter from the growth and decay of prairie vegetation.

This soil is well adapted to the production of corn and oats, which are the principal crops grown on it. Clover does fairly well, but considerable difficulty is sometimes experienced in getting a good stand. It is generally sown with oats, and if the season is dry the clover may die after the nurse crop is removed. The average yield of corn is about 40 bushels, while that of oats varies from 35 to 45 bushels per acre. Clover will yield during successful years from 1 to 2 tons of hay and from three-fourths to 1½ bushels of seed per acre. Fruit and vegetables are grown only for home use. Of the large fruits, apples and pears are most extensively produced, but the yields are light and the fruit is not of the best quality. Irish potatoes and some of the early vegetables can be successfully produced, but up to the present time they have been grown only for home use.

MIAMI LOAM.

The soil of the Miami loam, to an average depth of 16 inches, is a light-colored loam, in which the percentage of silt is relatively high. When wet or newly plowed it has a light-brown color, which on drying out becomes light or dark gray, and in some cases almost white. In general the soil resembles the Miami silt loam, but upon careful examination it is found to contain considerable medium to coarse sand. When thoroughly moistened, the soil is quite sticky and the presence of sand and small iron concretions gives it a gritty character. The soil is loose and light and is easily tilled, but is very deficient in organic matter.

The subsoil is a heavy, sticky loam, the upper section of which has a mottled yellow color, changing to deep yellow at lower depths. Some iron concretions occur in the first 6 or 8 inches of the subsoil, but below this depth they are not generally found. In some localities the soil at a depth of 14 inches grades into a sticky, gravelly subsoil, which resembles that of the Miami gravelly sandy loam. The gravel, however, is generally much smaller, and as a rule does not occur so abundantly as in the case of the Miami gravelly sandy loam subsoil.

There is usually found a slight quantity of small pebbles or gravel on the surface of this soil, and occasionally a few small bowlders, but not in sufficient quantity to interfere with cultivation.

The Miami loam covers only a small percentage of the area surveyed. It occurs as one continuous body on the uplands southwest of Lafayette, in the vicinity of Elston. The surface of the type is comparatively level, with but a slight fall toward the drainage channels. In some parts of the area the surface is slightly undulating, but the low knolls and ridges seldom exceed an elevation of 5 or 7 feet above the mean level of the type. Near the streams the surface is more broken and the boundary between this type and the valleys is often marked by a steep scarp from 80 to 100 feet high.

The natural drainage features of the type are poor, except on the more undulating areas and over that portion underlain by a gravelly loam at a depth of from 14 to 20 inches. Originally the soil was cold and wet, but this condition has been greatly improved by artificial drainage. A few low, wet areas needing drainage are still to be found.

The Miami loam is of glacial origin It is composed of the weathered products of a mass of ground-up rocks deposited upon the surface during Glacial times.

Corn is the principal crop grown upon this soil Wheat and oats are also grown to a limited extent, and some areas are devoted to pasture. The yields vary considerably, according to the seasons and the drainage conditions of the soil. Corn will average from 35 to 45 bushels, oats about 40 bushels, and wheat about 20 bushels per acre The type is well adapted to the crops at present grown upon it. It is quite probable that tobacco would do well, since this crop is successfully grown on soils of similar character in other sections, particularly in Ohio.

The following table gives the average results of mechanical analyses of typical samples of this soil:

Mechanical analyses of Miami loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13618,13977	Soil	0.8	12.1	8.1	5.8	3.6	52.5	16.9
13619,13978	Subsoil	.9	10.0	8.8	13.1	8.9	34.3	23.2

MIAMI FINE SAND.

The soil of the Miami fine sand consists of a loose, incoherent, medium to fine sand, in which the percentage of fine sand is extremely large. The color of the soil varies from light-brown to yellow, depending upon the amount of organic matter present, which is generally very small. The color usually becomes lighter with depth, and below 10 or 12 inches the soil grades into a light-yellow or gray subsoil having about the same texture as the soil. In the lower section of the subsoil the color is often mottled with brown and yellow, and in some cases pockets of gray sand are found.

There is a small area of the type northeast of Battleground in which the soil contains a larger percentage of organic matter than is generally the case, and the color is consequently somewhat darker, varying from light to dark brown. It rapidly becomes lighter with depth, and below 12 or 14 inches grades into a subsoil similar in character to that underlying the typical areas.

The following table gives the results of mechanical analyses of a sample of this type:

Mechanical analyses of Miami fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13624	Soil	0.0	2.9	13.3	52.0	11.5	13.8	6.4
13625	Subsoil	.0	3.0	13.3	49.6	13.4	13.5	7.1

The Miami fine sand is found bordering the Wabash River and as well-defined ridges on the uplands some distance back from this stream. The largest body is found south of Battleground, occupying a part of the second bottoms on the north side of the river. One or two small areas are also found along Wildcat Creek and its principal tributary.

The Miami fine sand has a topography similar to sand dunes, consisting of well-rounded hills and ridges varying from 5 to over 20 feet in height. Owing to the uneven surface and the open, porous nature of the soil, the drainage is generally excessive and crops are frequently injured by lack of sufficient moisture in the soil.

This type has resulted from the drifting of sand from the valley of the Wabash and its principal tributaries and its deposition in its present location by the action of winds.

Corn, melons, and sweet potatoes are the principal crops grown. The yield of melons and potatoes is generally good, but that of corn depends upon climatic conditions entirely. A few areas are covered with timber, consisting chiefly of oak, hickory, and walnut. It is a good truck soil and is also well adapted to small fruits.

MIAMI FINE SANDY LOAM.

The soil of the Miami fine sandy loam consists of a light to dark brown fine sandy loam, averaging about 4 inches in depth. The sand content varies in texture from fine to medium, with the finer material occurring in the upper part of the soil. The soil generally becomes slightly sandier and somewhat coarser with depth. Below 14 or 16 inches the soil grades into a medium sandy loam, which extends to an average depth of 30 inches. This section of the subsoil is very compact, the clay content being sufficient to give it a sticky character when wet. The color varies from light-brown to yellow. At a depth of 30 inches the subsoil grades into a brown coarse sandy loam containing considerable fine gravel and extending to an undetermined depth. Outcrops of the underlying material along road cuts and stream bluffs show this fine gravelly, sandy loam subsoil extending to a depth of from 4 to 6 feet, underlain by alternating layers of coarse sand and gravel. As the distance back from the streams increases, particularly near the Miami silt loam areas, the soil becomes heavier, in some cases approaching a loam, and the subsoil varies somewhat from that described above. In such localities the subsoil generally becomes heavier with depth, grading into a heavy fine sandy loam or light loam in which the silt content is high. The color is also somewhat lighter, varying from light gray to mottled yellow. This phase of the type is usually underlain by material similar in character to that underlying the typical Miami silt loam, although a few areas occur in which the subsoil grades at a depth of 3 feet into a layer of fine sand.

On some of the higher elevations and near the bluff lines the soil is sandier and the sand is somewhat coarser than is the case where the soil exists in its typical formation. The color of the soil, however, remains practically the same. This type, like the Miami silt loam, is markedly deficient in organic matter.

The following table gives the average results of mechanical analyses of typical samples of this soil:

Mechanical analyses of Miami fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13693,13999,14001.	Soil.........	0.6	6.1	8.1	22.0	8.5	40.6	13.5
13694,14000,14002.	Subsoil.....	1.2	7.5	8.0	23.1	7.9	31.1	21.0

The Miami fine sandy loam is confined exclusively to the northeastern part of the county, north of the Wabash River. The largest body occurs north and northeast of Battleground. Another area occupies that part of the upland between the Wabash and the Tippecanoe rivers.

Near the streams the surface of the type is somewhat broken and hilly, but farther back on the uplands it is rolling or slightly undulating. A few level areas occur, but these are generally quite small. The natural drainage of the Miami fine sandy loam is good, and in only a few cases has it been necessary to construct artificial drains. Over a considerable proportion of the type the drainage is excessive and crops frequently fail to mature on account of an insufficient moisture supply in the soil. The type has probably been formed by the deposition of loess, to which has been added the fine sand which has drifted upon the uplands from the valley of the Tippecanoe River.

The Miami fine sandy loam is well adapted to the crops grown in the county, with the exception of timothy, which requires a greater amount of moisture than this soil can retain during a dry season. Corn, oats, wheat, and some clover are the principal crops. Ordinarily corn will average 45 bushels per acre. The yield of wheat is about 20 bushels and of oats from 25 to 35 bushels per acre, depending upon the moisture supply. The yield of clover averages three-fourths of a ton per acre. Potatoes do well on this type, but it is difficult to estimate the

yield, inasmuch as they are grown onl
Apples and peaches are grown to son
also, but the quantity produced is s
The soil is well adapted to truck crop

MARSHALL FINE SA

In its typical formation the soil of
an average depth of 18 inches consists
It generally contains a large percenta
is due its prevailing black or dark-
becomes heavier as the depth increase
the surface it grades into a light-brow
to a depth of about 30 inches. The s
in the lower section, grading into a lig
ing to a depth of over 3 feet. In som
few inches thick and is underlain by l
totally absent, the type resting dire
depth of the soil varies in different lo
its topographic position. On the sl
ridges it has an average depth of abou
of a more sandy nature and the sand is
ridges, on the more level areas, and
deeper, occasionally exceeding 22 incl
is generally heavier than the typical s
cases. In some areas, especially on th
is found, but the amount is generally t
the agricultural value of the soil. O
are found.

The following table gives the averag
of this soil type:

Mechanical analyses of Mar

Number.	Description.	Fine gravel.	Coarse sand.	Me s
		Per cent.	*Per cent.*	*Pe*
13622,13985	Soil	0.1	7.1	
13623,13986	Subsoil	.6	17.2	

The largest body of Marshall fine s
part of the county, immediately so
smaller area occurs northeast of Bat
found in the northwestern part of tl
areas occur in the county, principall
parts.

The surface of the greater part of
some parts of the county the type o

running approximately parallel with the Wabash River. The natural drainage of the Marshall fine sandy loam is excellent. Owing to the uneven surface of the greater part of the type water runs off quickly, and artificial drainage is seldom necessary except on the more level tracts and in local depressions. On the lighter areas, particularly those underlain by a light subsoil, the drainage may be excessive, but in most cases the soil withstands drought well.

This soil type is for the most part of glacial origin. A few small areas have been formed by the mixing together of the Miami fine sand and the Marshall loam, forming a transitional zone between the two types. There have been added to this soil large quantities of organic matter through the growth and decay of prairie vegetation.

Corn, wheat, oats, and clover are the principal crops grown on the type. During wet seasons those areas of the soil underlain by sand produce better crops than those having a heavy subsoil. The latter, however, give better results than the former during a dry season, being better able to withstand drought. Corn averages about 40 bushels, wheat 20 bushels, and oats from 35 to 45 bushels per acre. Clover yields about 1½ tons when cut for hay and from three-fourths to 1 bushel per acre when grown for seed. Potatoes do well on this type, but are at present grown only for home use. Some fruit is raised, but is not of good quality and the yields are small.

RIVERWASH.

The Riverwash consists chiefly of coarse sand and waterworn gravel. It occurs as narrow strips, seldom exceeding one-quarter of a mile in width, along the Wabash River and its principal tributaries. It has been formed by the deposition of material along stream courses during periods of high water. The surface is low and flat and occasionally broken by old stream channels. It is generally dry during the summer months, and during wet periods it is covered with water. Owing to the small amount of fine material in this soil it is unproductive and has no agricultural value. Cottonwoods and willows, with some water-loving shrubs, are about the only vegetation found on this type.

WABASH SANDY LOAM.

The soil of the Wabash sandy loam consists of a sandy loam in which the percentage of coarse sand is extremely high. The average depth of the soil is about 12 inches, but this varies in different localities, the soil being deeper as well as slightly heavier in the depressions. On the ridges the soil is of a more sandy nature and is frequently covered with considerable fine gravel. The gravel is generally less than 1 inch in diameter and is more or less irregularly distributed throughout the soil profile. The prevailing color of the soil is dark brown, but it is sometimes slightly reddish, becoming lighter colored with depth.

At about 12 inches the soil grades into a coarse, slightly sticky, loamy sand subsoil which extends to a depth of over 3 feet. Small gravel is also found in the subsoil. The color varies from yellow in the upper part of the subsoil to pale yellow at lower depths.

The following table gives the average results of mechanical analyses of typical samples of this soil:

Mechanical analyses of Wabash sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13604,14021	Soil	5.2	27.5	14.9	25.6	8.9	12.0	5.4
13605,14022	Subsoil	3.7	25.0	15.5	28.9	9.4	12.1	4.6

The following sample contained more than one-halfl of per cent of calcium carbonate ($CaCO_3$): No. 14022, 1.3 per cent.

The Wabash sandy loam occurs only in limited areas along the Wabash River and its principal tributaries. It usually borders the bluff lines where typical second bottoms have not developed. The type has resulted from the washing of material from the uplands and coarse sand and gravel from the exposed bluff lines, together with material deposited by streams, its formation being due entirely to stream action.

The surface is generally uneven, consisting of low knolls and ridges and shallow depressions. A few level areas occur, but these are not very extensive. Owing to the open, porous structure of the soil the drainage in most cases is excessive, but this depends upon the relative position of the soil with respect to the streams. While not occupying the flood plain proper, it is nevertheless partly overflowed during excessively wet seasons. During the growing season the streams are generally low and the crops are seldom injured by floods.

Corn and melons are the principal crops grown on this soil. The yield of melons is generally good, but that of corn depends largely upon the quantity of rainfall during the growing season. In favorable seasons the average yield of corn is about 30 or 40 bushels per acre.

WABASH FINE SANDY LOAM.

The Wabash fine sandy loam varies to a marked degree in different parts of the area. Where typically developed, the soil consists of a fine sandy loam having an average depth of 16 inches. The fine sand content is quite large and generally increases with depth. The color varies from light to dark brown, the latter predominating. As the depth increases the soil becomes lighter both in color and texture, grading at about 18 inches into a light-brown fine sandy loam or loamy fine sand. The loamy material gradually decreases with depth, and at about 30 inches a gray fine sand is encountered which extends to a depth of more than 36 inches. Very frequently at this and lower depths the fine sand grades into gray coarse river sand and finally into gravel. In some localities the type, particularly the subsoil, is stratified. The soil in such cases is a light fine sandy loam, of a light to dark brown color, to a depth of about 14 inches. This is underlain by a fine gray sand, with an average thickness of 4 or 5 inches, which in turn is underlain by a brown fine sandy loam containing considerable silty material. This layer is about 5 inches thick, and beneath it is a medium gray sand extending to a depth of over 3 feet and becoming coarser with depth. In the depressions or over areas where the velocity of the stream was greatly retarded, thus permitting the deposition of the finer material carried by the streams, the type is much heavier, consisting in some areas of a light loam and in others of a silty loam. The color of the soil throughout these variations is the same as where the soil is typically developed. The organic matter content is generally small, but a few areas are found where considerable organic matter has been added to the soil. In such areas the color is a very dark brown and in some cases almost black. Some fine gravel is occasionally found on the surface, but the quantity is too small to have any effect upon the agricultural value of the soil.

The following table shows the average results of mechanical analyses of typical samples of this soil type:

Mechanical analyses of Wabash fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13606, 14023	Soil	Trace.	0.5	2.2	19.9	24.4	44.6	8.3
13607, 14024	Subsoil	0.1	1.1	2.1	20.3	26.5	40.3	8.9

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 13606, 7.8 per cent; No. 14024, 1.5 per cent.

A few small areas of this type are found along the Wabash River in the western part of the county. It is most typically developed along the more important tributaries of the Wabash, especially along Wildcat Creek, Sugar Creek, and Tippecanoe River. It occupies the first bottoms or flood plains of these water courses and has a width seldom exceeding three-fourths of a mile.

The surface of this soil is fairly level, with a gentle slope toward the main stream channels. A few low sandy and gravelly knolls and ridges occur, but they seldom exceed an elevation of 3 or 4 feet above the mean level of the type. The surface is also broken by sloughs, swampy depressions, and old stream channels.

The Wabash fine sandy loam is of alluvial origin, having been deposited in recent times by the streams which it borders. Because of its low-lying position the type is frequently flooded, but the sandy texture of the soil allows the water to drain off quickly, so that it is possible to plant crops quite early in the spring. Occasionally crops are injured by late floods and have to be replanted; but as a general rule crops on this soil are earlier than on the uplands.

Corn is about the only crop grown on this soil, and the average yield in favorable seasons is 45 bushels per acre. Some clover is grown, particularly on the higher and better drained areas, and yields fairly well. During dry seasons, especially when the streams are very low, the crops suffer from drought and the yield is very small. This soil is well adapted to truck crops.

WABASH SILT LOAM.

The soil of the Wabash silt loam consists of a heavy silt loam or clay loam, with an average depth of 18 inches. It contains only a small percentage of decayed organic matter, and the characteristic color is light or dark brown. The soil is quite sticky when wet. If allowed to dry without stirring, it has a tendency to bake and crack, and if plowed when too wet or too dry it forms clods which are difficult to pulverize unless moistened by rain.

The Wabash silt loam is remarkably uniform in character over most of the area. Where found along the smaller stream courses, the color of the soil is generally much darker, the amount of organic matter is larger, and more fine gravel occurs on the surface than is the case where the soil is typically developed. These areas resemble somewhat the Miami black clay loam, but the color of the soil is generally much lighter.

As the depth of the soil increases the percentage of clay also increases, and below 18 or 20 inches it grades into a heavy silt loam subsoil, which gradually becomes heavier, grading in turn into a silty clay, which extends to a depth of over 3 feet. Over the greater part of the type the color of the subsoil is much like that of the soil, but in some localities it is slightly mottled. There is no distinct line of separation between the soil and subsoil, and the change from one to the other is marked only by the gradually increasing clay content.

The following table gives the results of mechanical analyses of a of a typical sample of this soil type:

Mechanical analyses of Wabash silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13626	Soil	0.0	Trace.	0.3	27	2.1	66.1	28.4
13627	Subsoil	.0	0.0	.2	27	3.2	62.2	31.9

The Wabash silt loam occupies the first bottoms or flood plains along the Wabash River. A few small areas are also found along its principal tributaries. The surface is fairly level, with gentle slope toward the stream beds. The elevation of the type varies in different parts of the valley, in some places rising gradually from the streams to the bluff line, while in other localities it occurs in the form of broad, flat terraces or steps. Often as many as three of these step-like elevations occur between the river and the bluff line, each having a rise of from 2 to 3 feet. In some parts of these bottoms the surface of this type is cut by old stream channels, sloughs, and swampy depressions. In general the natural drainage of the type is poor. During wet seasons in the spring the greater part of the bottoms is flooded, and it not infrequently happens that early-sown crops are destroyed. As a rule, however, the bottom lands are late in drying out in the spring, so that by the time crops are planted the danger of floods is past. It is seldom that a crop is destroyed during the growing season.

This soil type owes its origin to the deposition of material brought down by the river during periods of high water. Corn is about the only crop grown, and the type is admirably adapted to this crop, yielding in favorable seasons from 50 to 60 bushels per acre. Occasionally, if the crop has been late in getting started, it is injured by early frosts. Clover does well on the higher and better-drained areas, yielding from 1 to 2 tons of hay per acre.

MUCK.

Muck consists of more or less thoroughly decomposed vegetable mold mixed with varying amounts of mineral matter. Over most of the Muck areas in this county the vegetable matter is thoroughly decayed, but in a few areas it is only slightly decomposed. These latter areas could be more properly classed as Peat, but on account of the small extent of the type a separation was not made. The peaty areas consist of coarse, raw, fibrous matter in which the vegetable tissue has been only slightly decomposed. Over these areas the soil is light and chaffy, contains some fragments of shells, and gives a slight effervescence when tested with hydrochloric acid. The color of the soil varies from dark-brown to black, being darker in those areas where the vegetable matter has been more thoroughly decomposed. The depth of the soil varies from 2 to several feet. The subsoil of those areas occurring along the streams consists of all grades of light-colored sand and gravel, while that underlying the type on the uplands is composed largely of dark-gray to mottled yellow clay loam or clay, the color here depending upon the depth to which the organic matter extends.

This soil type is not extensively developed in Tippecanoe County, and occurs as small, isolated areas, mostly in the southern and southwestern parts of the county. Along some of the streams the type marks abandoned channels that have passed the lagoon stage, where the soil has been formed by the long-continued growth and decay of aquatic vegetation. Some of the areas occur at a considerable elevation above the present stream channels, so that it is probable that the moisture necessary to the growth of muck-forming vegetation was supplied by seepage from the bluffs.

The natural drainage is poor. When artificially drained the type is adapted to the production of corn, potatoes, onions, and celery. It is also well suited to rape and timothy and other grasses. Corn is the principal crop grown. On some areas of the type good yields are secured, but on those areas where the soil is light and chaffy, resembling Peat rather than Muck, the crop is poor both in yield and quality and very frequently fails to mature. Oats and other small grains can not be successfully produced, because the large organic-matter content forces the growth of straw at the expense of the grain, and the crops lodge badly.

MIAMI GRAVELLY SANDY LOAM.

The soil of the Miami gravelly sandy loam to a depth of 12 or 14 inches consists of a sticky, heavy coarse gravelly sandy loam. The color varies from light to dark brown, and in some cases is a reddish-brown. The surface is generally covered with considerable gravel, which is seldom more than 1 or 2 inches in diameter. Gravel also occurs distributed through the soil, and as a rule increases in quantity with depth. The greatest quantity is found on the crests of hills and ridges and gradually decreases on the lower slopes.

The soil grades at about 14 inches into a light-brown heavy sandy loam in which there is considerable coarse sand and fine gravel. Small gravel is also found in the subsoil, the size and quantity generally increasing with depth. From 30 to 36 inches below the surface a layer of gravel is encountered which extends to an undetermined depth. Very frequently pockets of coarse sand and gravel occur in the hills and ridges, but these are seldom over a few rods across. On such areas the soil consists of a dark-brown coarse sandy loam to a depth of 10 or 12 inches, below which it grades into sand and small gravel. Below this material the subsoil is composed of alternating layers of sand and gravel, with the gravel gradually increasing in size with depth. Near the base of ridges and along the foot of terrace lines the soil generally becomes sandy and less gravel is found. The sand is also much finer.

The average results of mechanical analyses of fine earth of this type are given in the following table:

Mechanical analyses of Miami gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13598,14013	Soil	4.0	22.4	15.1	18.3	7.4	19.9	12.3
13599,14014	Subsoil	2.7	20.9	12.6	16.7	9.2	20.0	17.7

The Miami gravelly sandy loam is found on the uplands, principally in the southwestern part of the county, and on well-developed terrace lines along the streams. While occupying different topographic positions, there is little variation in the texture or the crop value of the soil, so far as could be observed in the field.

This soil is of glacial origin. The low hills and ridges which occur to a limited extent were probably formed by the action of ice and probably were at one time covered with loess, which has since been removed by erosion. The soil of the terrace lines is composed of glacial material which has been slightly modified and reworked by stream action. The surface of the type on the terraces is level or gently rolling, while on the uplands occur low, well-rounded hills and ridges. The type in general possesses good natural drainage. In some cases, especially on the more elevated areas, the drainage is excessive and crops do not do well unless there is an abundance of rainfall. The soil has, however, the power of retaining moisture exceptionally well, considering its coarse, gravelly texture. The crops produced do not as a rule suffer from drought as much as those grown on the Sioux sandy loam.

Corn, clover, oats, and wheat are the principal crops. The yields are generally best when the rainfall is quite evenly distributed throughout the growing season. The yield of corn is about 30 bushels, oats 25 bushels, and wheat from 10 to 15 bushels per acre. Clover will yield from 1 to 1½ tons of hay and from three-fourths to 1 bushel of seed per acre.

SIOUX SANDY LOAM.

The surface soil of the Sioux sandy loam consists of a medium to coarse sandy loam with an average depth of about 16 inches. The sand content is quite high and usually increases with depth. The color varies from light to dark brown and in some areas where the soil contains more organic matter the color is somewhat darker. Fine gravel is found on the surface and through the soil. There is no sharp line of demarcation between the soil and subsoil, but the change from one into the other is gradual. At a depth of from 14 to 18 inches the soil grades into a sticky coarse sandy loam or sandy clay

subsoil containing considerable
content generally increases wit
inches a bed of coarse gravel
undetermined depth. The col
more of a reddish tinge than
soil varies somewhat from its t
amount of gravel and the grave

The following table gives the
of samples of this type:

Mechanical anal

Number.	Description.	Fine gravel.	Co sa
		Per cent.	*Per*
13602,14019.......	Soil.........	2.2	
13603,14020.......	Subsoil.....	3.5	

The Sioux sandy loam is an o
second and third bottoms are
most typically developed along
and their tributaries. The soil
coarse material which forms th
the streams had sufficient veloci
Following the deposition of th
loamy material was deposited
ished, thus forming a sandy lo
slightly undulating. The level
of the terraces and uplands, wh
the surface becomes more un
broken by shallow abandone
flowing from the uplands.

Owing to the topographic p
texture, and the fact that it i
natural drainage conditions are
sive, and except during seaso
suffer from lack of moisture. T

Corn, wheat, oats, and clover
soil. The crop yields are heavi
yield of corn is about 35 bushel
20 bushels, and clover about 1½
1 bushel when raised for seed.
to these crops and is generally
soils in the county.

SIOUX LOAM.

The soil of the Sioux loam consists of a dark-brown to black loam about 15 inches deep, containing a large percentage of silt, some coarse sand, and a few pebbles or fine gravel. The dark color is due to the large amount of organic matter present. The subsoil is a brown or reddish-brown loam of about the same texture as the soil and is underlain at an average depth of 2 feet by a bed of gravel many feet in depth, which constitutes the chief material of the river terraces. In some places this gravel comes to the surface, and these small areas are of low agricultural value.

The only area of this type occurs upon the high terrace immediately southwest of West Lafayette. The State University farm is located upon it. The surface is nearly level, but the underlying gravel bed gives thorough underdrainage. In fact, the lower subsoil is so open and porous that water readily passes through it, causing crops to suffer quickly from drought. The large amount of organic matter present in the soil assists greatly in the retention of moisture, thus diminishing the damage from this cause.

This soil type consists of glacial material reworked by the swollen streams at the close of the Glacial epoch. The sand and gravel were laid down by swift currents, but when the water began to subside finer material was deposited, giving rise to the thin layer of loam over the coarser sand and gravel.

The yields upon this type depend very largely upon the rainfall and the depth to the underlying gravel. Where the layer of loam is 2 feet or more deep large yields are secured in seasons of abundant rainfall. A drought at the critical period in the growth of a crop causes a very decided decrease in the yield.

A sample of this soil taken from the university farm, 20 rods south of the experiment station building, was studied by the paraffined wire-pot method to learn something of its manurial requirements. The soil is a dark-brown or black loam. It contains some coarse sand, and a few pebbles and fine gravel are found on the surface, while the subsoil is of a gravelly nature. The field from which the sample was taken has been in corn continuously for the last twenty-five years without the use of manure or other fertilizer.

The results obtained indicate that a large increase in production may be obtained by the use of stable manure; that nitrate of soda and sulphate of potash will give a small increase; while only a very small increase may be obtained by the use of any other form of fertilizer tried. Lime alone or with cowpeas or acid phosphate slightly diminished the yield.

In these tests wheat plants were used as an indicator, and the results are held to be applicable only to this crop and to the particular field from which the sample was taken, but they are believed to apply in a general way to this soil throughout a large part of the area.

SI

The soil of the Sioux silt
friable silt loam with an ave
very large percentage of orga
The subsoil consists of a yell
taining brown iron stains an
from 3 to 6 feet the silty depos
which extends to a depth of m

The Sioux silt loam occupie
only occurrence being found u
River and is covered almost e
features of the type are gen
lying gravel bed insures good

The soil was probably form
was deposited upon the upla
laid down by the swollen strea

The Sioux silt loam is a s
capable of large yields of gene
type, however, is covered by
is under cultivation.

AGRICU

The cultural methods gen
almost exclusively to the pr
many farms, particularly thos
is grown, and corn, oats, and

In the preparation of the l
depth for both spring and fal
the land has been in corn the
to stir up the ground, after
pulverizing and leveling the
but the general practice is t
vate both ways. Shallow c
deeper cultivation is frequent
are especially troublesome.
cut for ensilage, while on a l
corn binder, shocked, and hus
widely practiced, however, as
corn is husked from the stan

Oats are generally sown b
harrow used to loosen the sur
the land is harrowed after dis
cut with self-binders and thra

Winter wheat is a somewha
and quality. Many farmers,

colored soils, continue to grow this grain, because it alternates easily with either corn or oats and clover, making an excellent nurse crop for clover and affording a needed change in the crop series. Some farmers drill their wheat in the cornfield between the rows of stalks, using a one-horse drill for this purpose. This method is satisfactory if the ground is free from weeds and the seeding is done somewhat earlier than if sown on open land. A large proportion of the wheat grown is sown on land that has been in oats the previous season. Soon after the oat crop has been removed the stubble land is plowed to a depth of 4 or 5 inches and well harrowed. The seed is drilled in, usually during the last two weeks in September. It has been observed that the best fall growth is obtained when the seed bed is prepared as early as practicable. This is probably due to the fact that the soil moisture is thus conserved, usually a very necessary factor at this season of the year.

Timothy and clover are quite extensively grown for hay. On the typical prairie soils, particularly the Marshall loam, clover is sown with oats, as wheat can not be grown on this soil; but on the lighter soils wheat is preferable with clover, because it draws less upon both the moisture content and the available plant food of the soil, and consequently there is less danger of the clover doing poorly after the nurse crop has been removed. The first crop of clover is cut for hay, but if the second crop promises a good yield of seed it is allowed to ripen and is thrashed.

There are practically no farms upon which a systematic rotation of crops is practiced. In certain parts of the county, however, it has been found unprofitable to grow the same crop continuously for any considerable length of time upon one field. In such cases the rotation considered by the farmers as best adapted to the soil is one or possibly two years of corn and one year of oats or wheat. If oats are grown, they are followed by wheat, used as a nurse crop for clover. In some cases the oat crop is omitted and the rotation practiced is one year of corn, one year of wheat, and one year of clover. On the heavier soils corn and oats, with an occasional crop of clover, is the rotation generally practiced. Many farmers grow corn as long as possible, the land being planted to this grain for three or four seasons, and then one crop of oats is raised. In some cases the farmers alternate corn and oats from year to year. In either case clover is generally introduced once in four or five years. The limited quantity of barnyard manure on hand is usually applied to land intended for corn. Commercial fertilizers have been tried in some parts of the county, but their use is not becoming general.

AGRICULTURAL C

During the last five years there ha valuation of farms in the county. Tl in the average price of agricultural high rents which good lands readily co lands and implements according to th The majority of the land owners are as much can not be said of the tenan living, but are not, as a rule, acqui their teams, farming implements, an hogs. In the last fifteen years man town and now live upon the rent rece neighborhood the number of tenant many men who own and live upon tillable land, and thus avoid the em details of farm management. More farms and a large proportion of the c tenants. According to the census o farms of the county were operated by

The usual rent paid is one-half the ants deliver the grain at the elevator fixed cash payment for the use of the cash rent for good land varies from size of farms for the county is 118. county which were formerly timbere than on the prairies. There are a fe more, but these consist of separately

How to secure necessary farm labo the farmers of Tippecanoe County, a largely responsible for so many of the to town to live. About $270,500 is farm hand receives from $22 to $25 and a horse if he wishes to keep one. husking corn, and wages for other ki $1.50 a day.

There is considerable difference in ferent soil types. The Marshall loan the best corn soils and are worth from areas of the Marshall fine sandy loan value, but some of the sandy phases o a gravelly subsoil are rated somewha ceptibility to drought.

The topography of the Miami silt cultural value. Broken areas along pasture, and some areas are in timber. The level areas have a market value somewhat lower than similarly improved farms of the Marshall loam and Marshall silt loam.

On the Miami fine sand and the Wabash fine sandy loam melons, small fruits, and early truck are successfully grown for the home market. Some of the Miami gravelly sandy loam and much of the Miami silt loam is adapted to apples, pears, and peaches. The poorer quality and lower yields of these fruits, compared with those reported a few decades ago, are doubtless due to causes other than those which may be attributed to the soil. The orchards are usually located without regard to the slope of the land or protection from wind, while the study of varieties adapted to this locality and the necessary care of the trees are almost wholly disregarded.

The variety of soils in the county affords opportunity for a diversity of products, but the tendency toward the exclusive production of grain is shown by the fact that the annual acreage of corn—approximately 100,000 acres—is 30 per cent greater than it was twenty years ago. The area now devoted to oats is about 50,000 acres, or nearly five times as much as it was two decades ago. The acreage of wheat varies from year to year, but is steadily decreasing.

With the exception of wheat, which often fails to mature well, the quality of the grain is generally good. Much of it, however, fails to grade well on the market on account of being damaged before leaving the farm. Oats and wheat usually remain in the shock until they are thrashed, and a great deal of corn, especially on the rented farms, is carelessly cribbed.

All of the wheat and nearly all of the oats are shipped out of the county. Of the 3,250,000 bushels of corn annually produced, about 65 per cent is sold at the elevators.

The comparative ease with which these cereals can be grown and harvested with the aid of machinery and the sure returns they afford commend them to both the landowners and the tenants. This system of farming is recognized as exhaustive of the soil, but clover is considered an easily introduced restorative. Too much dependence, however, is being placed upon this legume. Generally the first crop is cut for hay and the second is harvested for the seed, so that most of the vegetable matter above ground is removed from the field. While the nitrogen supply is reasonably well maintained, very little humus is added to the soil. The physical condition of all the upland types, excepting recently drained areas, is not so good as formerly. More labor and better methods are required to keep the soils in good condition during the growing season.

On the average farm the amount of manure produced is small as compared with the acreage of land cultivated. This is due to the small number of cattle usually kept. Cattle feeding has greatly

declined of recent years, and d
extent except in the neighborh
a tenant can keep is restricted
while the farmers living on th
young stock. This limits the
profitably for pasture. The t
has decreased during the last t
at Lafayette for oat straw, a g
from the farms.

Under present conditions th
methods of farming which m
results are already apparent in
most of the farmers living on t
sified lines of farming, especia
not for the high cost and unrel
which can be secured. This is
prospect of immediate improv

Stock raising is a profitable
personal attention. Most of t
fed to hogs. On most of the
greater than that received fro
stock. There are a number of
stock breeding. Some well-b
are to be seen, and some excell

Lafayette furnishes a good
in the county. The Wabash, t
Indianapolis and Louisville, a
and St. Louis railroads pass th
ping facilities to Chicago, St.
Louis and Western Railroad
county. There are 17 elevat
points on these lines. There a
now in operation. The count
well graded, and more than 1,0
with gravel.

SOIL SURVEY OF THE CARL
WISCON

By W. J. GEIB and GR

LOCATION AND BOUNDAR

The area surveyed lies in the northe
head of Lake Superior, and includes
48, and 49, ranges 15, 16, 17, and 18.
County, Minn., while the St. Louis River equally divides the territory of the remaining three between St. Louis County, Minn., and Douglas County, Wis. The west boundary line of the Superior area, which was surveyed during the season of 1904, forms the east boundary line of the Carlton area.

Carlton, the county seat of Carlton County, lies at the junction of the Great Northern and Northern Pacific railroads, and has a population of about 600. Cloquet, with a population of 6,000 and located 6 miles north of Carlton, is an important lumber center and
has the reputation of having the large
town in the United States. Scanlon, T
Fond du Lac, and Smithville are t
small portion of West Duluth is inclu
num, a town of about 500 population,
corner of the area.

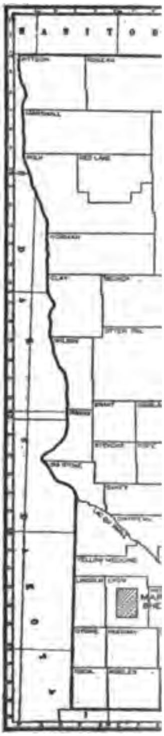

FIG. 34.—Sketch

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

As early as 1650 the region about the head of Lake Superior was visited by fur traders and explorers, and about 1659 a trading post was established at Fond du Lac, a few miles from the mouth of the St. Louis River, which was at that time known as the Fond du Lac River. This waterway afforded the only means by which the interior could be reached, and down the St. Louis came a good portion of the furs shipped from the head of the lake in early days. Game was plentiful in this region, and for a century and a half Fond du Lac was one of the leading posts of Lake Superior.

From 1659 to 1854, a period of nearly two hundred years, the area surveyed was visited by the fur trader, the missionary, the pioneer, and the officers of the Government, and a few settlements were made; but through all this period it is not known that any attempt was made to cultivate the soil to any extent, and no towns were built of any more importance than a trading post or mission station.

In 1847 a treaty was made at Fond du Lac between the Chippewa Indians and the United States Government, by which the greater part of northern Minnesota was ceded to the United States and opened for further exploration and settlement. The Indians were usually kindly disposed and gave the early settlers but little trouble.

Minnesota Territory was organized in 1849, and in the same year the Territorial legislature created Itasca County. This embraced the vast region lying between the Mississippi River and Wisconsin Territory and extended from 46° 30′ north latitude to the Canadian boundary line. From this domain the counties of St. Louis, Cook, Lake, a part of Beltrami, and Aitkin were created, and in 1857 Carlton County was created from a portion of St. Louis, though it was not reduced to its present limits until 1870.

By 1854 Fond du Lac, Minn., and Superior, Wis., had become ports of considerable importance, and up to that time their only means of communication with the outside world was by boat over the lakes to eastern points or through the unbroken forest to points on the St. Croix and Mississippi rivers. Through the efforts of the district representative Congress made an appropriation for the building of the military road between Fond du Lac and Superior and St. Paul. This road was completed in 1856, and its establishment greatly facilitated travel, made possible greater regularity in the mail service, and stimulated the desire for developing the resources of northeastern Minnesota.

The agricultural history of the area may be said to have begun with the first settlement made on the old military road at Twin Lakes, in Carlton County. Several small farms were cleared and put under cultivation during that year, and since that time the development of

the community has been comparati
Twin Lakes no longer exists.

The first railroad built in northeas
area was the Mississippi and Lake Su
and St. Paul Short Line and operate
road. This line was completed in 187
development of the lumber industry.
little interest had been manifested i
existed, but after the completion of
panies saw the opportunity to reap a r
ous sawmills were put into operati
Mahtowa, Carlton, Thomson, and Cl
bering centers.

In the early days of the lumbering i
best trees were cut, but as the timber
greater every tree which could possi
present the pine within the area is pr
amount of timber remaining consists

Cloquet and Scanlon are now the
which sawmills are operated. The t
down the St. Louis River or brought
miles distant.

The land stripped of timber was al
men had left it. The old trunks of t
grew up each season and died down in
place for the forest fires, which did
often destroyed many lives.

The pine lands were at first conside
cultural purposes, and consequently
has been slow. As the timber becam
of those who had worked in the wood
bering industry to new timber lands, t
to make for themselves a home in
Other settlers came in slowly, and it
oats, hay, and vegetables could be g
soils.

The lumber companies which had
were willing to sell very cheaply, and
part of the "cut-over land" was in the
who proceeded to bring the attentio
northeast Minnesota.

In 1870 the population of the regio
veyed was about 400, and by 1900 it
Early immigration came largely from
the last fifteen years Germany, Norwa
largely to the growing population.

CLIMATE.

As the Weather Bureau has no stations within the area surveyed, no records are available which deal directly with the climatic conditions as they exist. The data given below are from the Duluth station, which is about 3 miles distant from the northeast corner of the area, and from the station at Sandy Lake Dam, which is 60 miles west of Duluth. The records from the former will be found fairly accurate for the eastern part of the area, which is more subject to the influence of the lake, while for the conditions of the west half of the area the latter should be consulted.

A temperature of 99° F. has been recorded at the Duluth station, and the thermometer has gone as low as $-41°$, so that the extreme range of temperature is about 140° F. During the last twenty-seven years the average date of the last killing frost in the spring has been May 2, and the first in the fall September 30. The latest killing frost known in this region occurred June 8, 1885, and the earliest in the fall September 15, 1874. The average annual snowfall is 40 inches.

During eight months of the year the prevailing winds are from the northeast, but for the remaining four, including the growing season, they are from the west and southwest. While the growing season is comparatively short and usually late in opening, vegetation makes a very rapid growth when the warm weather begins. The rains are equally distributed throughout the growing season and crops do not suffer from drought. The greatest precipitation occurs in June in the form of thundershowers.

Normal monthly and annual temperature and precipitation.

Month.	Duluth.		Sandy Lake Dam.		Month.	Duluth.		Sandy Lake Dam.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	*°F.*	*Inches.*		*°F.*	*Inches.*	*°F.*	*Inches.*
January	10.4	1.07	6.1	0.85	August	64.7	3.34	64.5	3.81
February	14.7	1.15	6.2	.75	September	56.2	3.86	55.7	2.29
March	24.0	1.66	....	1.51	October	44.9	2.59	44.3	2.53
April	37.9	2.42	40.5	2.20	November	29.4	1.61	26.1	1.01
May	48.0	3.68	53.4	3.07	December	17.8	1.36	11.7	.87
June	57.8	4.59	62.6	3.22					
July	65.9	3.72	67.0	3.86	Year	39.3	31.05	....	25.97

PHYSIOGRAPHY AND GEOLOGY.

The topography of the Carlton area is characteristic of a glacial region and varies from low, almost level plains to rolling and hilly uplands. There are three distinct physiographic divisions, consisting of the glaciated uplands, the old outlet to Lake Superior through which the water of the lake was formerly carried to the southwest, and the

Nemadji Plains, consisting of lacustrine
extension of Lake Superior.

The surface of the glaciated uplands
rolling and hilly. This irregularity is
of the glacial and morainic material on
erosive action of glacial streams thro
material were carried into glacial lakes,
of the streams which now pass throug
bounded on the east by a range of hil
Lake Superior in the vicinity of Dulut
at Short Line Park. This range has a
Lake Superior is 602 feet above sea
effected, generally, within an interval
Duluth there is a narrow strip of level
hills and the shore of the lake, which
toward the southwest. The steeper sl
series of rugged rock outcrops, while o
surface is thickly strewn with stones an
ward from the range of hills the eleva
uplands already described, which at a p
near the north line of Carlton County, r
Another range of hills begins at a poi
Carlton, on the south side of Otter C
westerly direction for 5 miles. It vari
and is composed largely of morainic ma

The greater part of the course of t
area is bounded on both sides by high
and drift materials of the region. These
proper from one-half mile to 2 miles, a
cut by numerous drainage courses. Fr
du Lac the river flows on the bed rock,
the floor of the valley is thickly cover
series of rock outcrops on both sides o
bridge which crosses the river near T
vation of 50 feet. At Thomson the sur
trine, thus assuming the character see
immediate valley eastward from Thom
excavation than that part eroded thro

Otter Creek, which joins the St. Lou
an old channel between drift walls, wh
rated from each other by a distance o
channel is distinctly traceable for so
approximately in the direction of th
Line Railroad, but somewhat to the s
continues in a southwesterly direction

the valley of the Moosehorn River, which passes out of the area about 1 mile north of the southwest corner of the tract surveyed. This channel is probably the oldest and highest of the westward outlets of Lake Superior and was formed through the terminal moraine which bounded the Superior ice lobe in glacial times. The surface of this old channel is nearly level, but slopes gently toward the course of the stream.

The Nemadji Valley occupies the southeastern part of the area extending north to the St. Louis River and west to an imaginary line drawn from Thomson through Wrenshall to a point 6 miles east of Barnum, which is situated one-half mile west of the southwest corner of the area. This division is a lacustrine plain underlain by stratified clay and fine sand and is the most westward extension of the great valley of Lake Superior. Its westward boundary is distinctly marked by the abrupt change which takes place in the contours in passing to the drift area proper. The surface is nearly flat, but slopes gently toward the Nemadji River, which runs into Lake Superior. The streams have excavated canyonlike valleys in this deposit to a depth of from 40 to 100 feet, but so far as is known the bed rock has in no place been reached by the erosion.

The underlying rocks of the Carlton area have but little direct influence upon the soils. The formations belong to the Archean and Cambrian, and consist chiefly of slates, sandstone, and gabbro. While outcropping here and there in the area, these rocks are generally deeply buried beneath the glacial drift or glacial drift reworked and redeposited in ancient lakes. The largest outcrop occurs along the steep slope of the range of hills southwest of West Duluth.

The glacial drift, which everywhere covers the area to a depth of from 50 to 100 feet, was modified in part after the first deposition, and as a result we have considerable variety in the soils. The rolling glaciated uplands give rise to the Miami series, the types of which show marked textural differences, owing to the assorting action of water. In the northeast part of the area the predominance of fine material mingled with a relatively larger proportion of stone gives rise to a light loam termed Miami stony loam. In the western and northwestern parts the material consists chiefly of medium and fine sand with varying proportions of organic matter, and the soils derived therefrom are Miami sandy loam and Miami fine sand. In the southwestern part of the area there is a large quantity of fine particles in the material, giving rise to a heavier loam type. Where this is underlain near the surface by clay or clay loam it has been mapped Barnum loam, and where the subsoil is of a sandy nature grading into clay loam at a greater depth the type has been called the Barnum stony loam. This underlying clay is of a reddish color. In other parts of the rolling uplands a slight red color may often be seen. This colora-

tion is due to the presence of iron, whic
from the iron-bearing rocks to the north

The materials comprising the Nemadj
in Lake Superior when that body of w
present level. The sediment was derived
ited sheet of drift which covered the c
which underlies the Nemadji Valley is
from the rocks of the Keweenawan for
the sediment that lies on this, forming t
of from 4 to 50 feet, came more gener
color, which is prevalent here and whic
in most of the soils of the area, is due
soils which have been derived from this
series, of which the Superior clay, con
brought down by the glacial streams, oc
valley. The Superior silt loam, which
Nemadji Plain, was derived from materi
larger and heavier than the clay partic
their greater weight were deposited nea

SOILS.

Twelve soil types, not including rock
the area surveyed. The following tabl
tive extent of each type:

Areas of different

Soils.	Acres.	Per cent.	
Superior clay	75,200	28.8	Meadc
Miami sandy loam	54,784	20.7	Miami
Miami stony loam	50,560	19.1	Rock
Miami sand	17,408	6.6	Barnu
Muck	17,408	6.6	Miami
Superior silt loam	16,192	6.1	
Barnum stony loam	8,704	3.3	
Rough stony land	5,440	2.0	

MIAMI STONY LO

The Miami stony loam is the most in
the one upon which the greatest agricu
place. The soil consists of a brown
sandy, extending to a depth of from 10 t
lain by a heavy sandy loam or loam of
inches. Both soil and subsoil may c
gravel, and in local areas a gravel bed
feet. Where the larger amounts of gr

are larger. The surface is strewn with rounded and angular glacial stones and bowlders. The quantity of these present on the surface and mixed with the soil varies from 15 to 40 per cent, while the fragments range in size from 2 inches to 2 feet in diameter. Where the stones are most numerous they interfere considerably with cultivation and their removal is necessary before improved farm machinery can be successfully used.

The largest area of the Miami stony loam lies on the north side of the St. Louis River, and comprises about 65 square miles, extending from a point opposite Cloquet to the range of hills overlooking the basin of Lake Superior and reaching north to the boundary of the sheet. The continuity of this area is broken only by a few small Muck areas. The stones and bowlders are more numerous here than on the remainder of the type, and are often plentiful enough to interfere with cultivation, especially in the northeastern part. Another area of considerable size lies to the south of Carlton, and here the texture of soil is coarser. The stones are not so prevalent in this section and cause but little inconvenience in the various farm operations. Other small irregular occurrences of this type are found in various parts of the area.

In topography the surface of the type varies from rolling to hilly. The roughest portion lies in the northeastern part of the area, where the range of hills which extends to the northeast from Short Line Park marks the boundary between the upland and the valley of Lake Superior. South and east from Atkinson is a small area which is nearly level. Here the soil is a brown loam to a depth of 22 inches, underlain by a heavy sandy loam. Other low-lying areas of small extent occur throughout the type, and in these the soil is usually heavier than on the higher elevations.

On account of its uneven topography and the slightly sandy nature of its subsoil, the natural drainage over the great proportion of the type is good. The low-lying areas are often very wet during the spring of the year, and in some of these a condition approaching swampiness now exists. By cutting a few open drains, which would require but comparatively little labor, these areas could be readily reclaimed.

The soil of the Miami stony loam is derived from the glacial and morainic drift which covers the greater part of this region. The clay underlying this type at various places resembles the surface soil of the Superior clay, though of somewhat lighter texture, and was probably originally derived from the same source.

The estimated average yields from this soil are 35 bushels of oats, 30 bushels of barley, 1½ tons of hay, and 175 bushels of potatoes per acre. Wheat yields from 20 to 30 bushels per acre, though little of this grain is grown. Root crops and vegetables also do well.

The Miami stony loam is adapted t
stock raising, and should be devoted t
The following table shows the resul
fine earth of this type:

Mechanical analyses of M

Number.	Description.	Fine gravel.	C s
		Per ct.	*P*
13562	Soil	0.2	
13563	Subsoil	.5	

BARNUM STONY

The Barnum stony loam to a depth
brown loam, underlain by a heavy san
from 22 to 36 inches. On the surfa
stones and bowlders, which often occu
fere with cultivation.

The type is confined to the southw
and is of glacial origin. Its topogra
similar in this respect to the Miami st
age for the most part is good. Where
broken and the stones not too num
general crops of the region. Fairly go
can be grown.

The following table gives the result
fine earth of this type:

Mechanical analyses of B

Number.	Description.	Fine gravel.	C s
		Per ct.	*P*
13564	Soil	0.1	
13565	Subsoil	.4	

SUPERIOR C

The soil of the Superior clay to a d
cious red clay. The accumulation
matter at the surface has imparted to
color, and in a few local areas there
silty material covering the soil to a de
subsoil consists of a heavy, stiff, tena
cretions may occur on the surface and
wet the soil becomes very sticky, adhe
vehicles and greatly impeding travel.

The Superior clay is a very uniform type, and the boundary line between it and the other types can be readily traced by the increase in the elevation and the marked change in the character of the soil. It is found in the southeastern part of the area and there occupies an unbroken stretch of over 100 square miles. An imaginary line drawn from West Duluth through Fond du Lac and Barker to a point 7½ miles east of Barnum, which lies just outside the western limits of the survey, separates the main body of the Superior clay from the other types mapped. Directly east of Thomson there is a small, isolated area of clay, and at Wrenshall is another occurrence from which an excellent quality of brick is being manufactured. To the north and east of Wrenshall, and extending along the St. Louis River for several miles, the clay is overlain by a covering of fine sandy and silty loam, which gives rise to the Superior silt loam.

The surface of the Superior clay is level or slightly rolling. The Nemadji River, with the many small streams tributary to it, drains the larger part of the type. These streams have cut deep, canyon-like valleys through this deposit, and in a few instances the eroded channels are so close together and the slopes are so steep that the land is unfit for agricultural purposes. On account of the heavy, compact character of the clay artificial drainage will be necessary over a large proportion of the type before the soil can be cultivated with the greatest success.

The soil is a lacustrine deposit laid down in Lake Superior when that body of water stood some 500 feet above its present level. The sediment, which was derived largely from the sheet of glacial drift covering this region, extends to a depth of from 4 to 50 feet. The till underlying this is supposed to have been derived from the rocks of the Keweenawan toward the east.

Notwithstanding the Superior clay is the most extensive type, it is one of the least developed soils of the area. Only a few fields have been cleared and put under cultivation, but from these an idea of the agricultural value of the soil was obtained. The wild grasses, clover, and timothy do very well, and if the bushes were removed a good crop of wild hay could be cut each year. Hay yields from 1 to 2 tons per acre, while 40 bushels of oats is considered an average crop. Potatoes produce at the rate of 100 bushels per acre. The yields of the various crops are usually larger after the soil has been worked for a few years, for by continued cultivation and the mixing of more organic matter with the soil it loses to some extent its heavy, tenacious character. Excellent pasture is afforded throughout the summer and the type should be used for grazing and the production of hay.

The average texture of both soil and subsoil is shown in the following table of mechanical analyses:

Mechanical analyses of Superior clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
12925, 13570	Soil	0.4	1.5	1.6	8.3	6.4	21.8	59.9
12926, 13571	Subsoil	.1	.9	1.3	10.6	8.7	23.5	54.5

SUPERIOR SILT LOAM.

The soil of the Superior silt loam to a depth of from 6 to 10 inches consists of a light-colored very fine sandy or silty loam, underlain by a very fine sandy loam or silty loam, having in some places the properties of a clay and grading into a stiff red clay at varying depths. The underlying clay, which is of the same origin as the Superior clay, may be encountered at from 2 to 3 feet or it may lie many feet below the surface. The cuts along the Great Northern Railroad to the north and east of Wrenshall show this very fine sandy and silty material, which presents a stratified appearance, to extend to a depth of from 20 to 30 feet.

The largest area of the Superior silt loam lies between Wrenshall and the State line, extending north from Barker to the St. Louis River, and thence in a northeasterly direction to a point 2¼ miles north of Fond du Lac. A few irregular areas extend southwest from Wrenshall to the southern edge of the map.

Over the greater proportion of the type the surface is rough and broken, being deeply eroded by stream action. The slopes, which are now covered with a dense growth of underbrush, are too steep to be cultivated. The small areas to the southwest of Wrenshall are nearly level and when drained should be capable of producing fair crops.

The Superior silt loam is closely associated with the Superior clay. It is a glacial soil reworked by the action of water. The underlying clay was derived from the same source as the Superior clay, and the very fine sandy and silty material was probably carried down by glacial streams and deposited at a later date.

None of the type is now under cultivation, and on account of its uneven topography the greater part is of little value for agricultural purposes.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Superior silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
13572, 13574	Soil	0.3	0.9	0.6	1.8	11.3	67.9	16.3
13573, 13575	Subsoil	.4	.8	.5	2.0	7.1	65.8	22.6

MIAMI SANDY LOAM.

The soil of the Miami sandy loam consists of a brown or light-brown sandy loam of medium texture extending to a depth of from 8 to 14 inches. There is usually mixed with the soil a small amount of gravel, although there are considerable areas where the soil is entirely free from coarse material. The subsoil consists of a medium or coarse light sandy loam containing varying amounts of gravel and grading into beds of gravel or sand at from 2 to 3 feet. The pebbles in this gravel are much worn by the action of water and seldom exceed one-half inch in diameter.

About 86 square miles of the Miami sandy loam were mapped, the areas being confined almost entirely to the west half of the survey. The type occupies three-fourths of that part of the Fond du Lac Reservation lying within the area and extends south to the Moosehorn River and the Duluth and St. Paul Short Line Railroad. It is here found in one continuous body, broken only by small areas of Muck and Miami stony loam. From a point about 1 mile southeast of Atkinson an irregular area extends to the southern boundary of the survey, and over the greater part of this area the soil is of a coarser texture than the remainder of the type. Small areas also are found south of Wrenshall, along the border of the Superior clay.

The surface of the Miami sandy loam for the most part is undulating or rolling. A marked exception to this is found, however, in a range of hills which begins 1½ miles northwest of Atkinson and extends in a northeasterly direction for about 2½ miles. These hills vary in height from 20 to 40 feet and represent morainic material. The soil of this ridge is very light, contains a high percentage of gravel, and is underlain by a gravel bed at from 2 to 3 feet.

The soil of the Miami sandy loam is derived from glacial material, and that portion within the Fond du Lac Reservation and extending south probably represents a glacial flood plain. The small areas occurring along the border of the Superior clay were undoubtedly somewhat modified by the action of Lake Superior.

Another area of Miami sand is located near the center of that part of the Fond du Lac Reservation which lies within the area surveyed. Here the surface is but slightly rolling and there is a less amount of gravel present in the soil and subsoil than in the area just above. There are a few small patches throughout this part of the type in which the soil is of a coarse texture, and in these places a gravel bed is usually encountered at from 2 to 3 feet.

The Miami sand is a glacial soil, representing glacial flood plains and the accumulation of morainic material. On account of the loose, open character of the soil, together with its uneven topography, the natural drainage is good. In seasons of deficient rainfall crops suffer from drought, though this soil is more retentive of moisture than its open character would indicate.

About Sand Lake, where the type is under cultivation, fair crop yields are secured. Potatoes of excellent quality are grown and the yield ranges from 100 to 200 bushels per acre. A yield per acre of 30 bushels of oats is considered about the average, while in wet seasons hay yields from 1 to 1½ tons. Strawberries do well, and the portion of the type which is not hilly is well adapted to the growing of small fruit and truck farming.

The average results of mechanical analyses of the fine earth of the soil and subsoil appear in the following table:

Mechanical analyses of Miami sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per. ct.*
13552, 13556	Soil	0.9	11.7	19.1	56.3	7.0	2.0	2.8
13553, 13557	Subsoil	3.7	23.5	20.4	44.7	5.4	1.7	2.4

MIAMI GRAVELLY SANDY LOAM.

The soil of the Miami gravelly sandy loam consists of a gravelly sandy loam from 10 to 14 inches deep. The interstitial material varies from a medium to fine sandy loam or loam. The subsoil to a depth of 36 inches is a medium or coarse light sandy loam mixed with gravel and often grading into a gravel bed at from 2 to 3 feet. The higher elevations contain a high percentage of gravel and are usually underlain by a gravel bed, while in the depressions the soil is practically free from gravel.

About 9 square miles of this type were mapped. The largest area, which varies in width from one-half mile to 1½ miles, extends from Cloquet to a point 3 miles west of Carlton. Another area of much smaller extent lies to the north of Cloquet on the east side of the St. Louis River. The occurrence west of Carlton has a level surface, while the portion extending north to Cloquet forms a range of hills along the

The results of mechanical analyses of the fine earth of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Barnum loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
13560	Soil	0.8	3.1	7.2	18.2	10.1	42.8	17.3
13561	Subsoil	.7	1.7	3.4	10.9	10.4	45.1	27.8

MIAMI FINE SAND.

The Miami fine sand consists of a fine brown or light-brown sand 10 inches deep, underlain by a sand of the same texture, though lighter in color. Only 2 square miles were mapped. The type is located in the central part of T. 47, R. 17, where the surface material changes from lacustrine deposits to the glacial drift. The occurrence is in the form of low ridges and probably marks the old shore line of an arm of Lake Superior. None of the type is under cultivation, though it is well adapted to the production of early truck crops.

The results of mechanical analyses of a typical sample of the surface soil and subsoil of this type is shown in the following table:

Mechanical analyses of Miami fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
12929	Soil	0.3	3.5	9.9	58.6	17.8	5.7	4.2
12930	Subsoil	.3	2.7	12.9	64.1	16.0	2.4	1.6

MUCK.

The surface materials of the Muck consist of organic matter in varying stages of decomposition, accumulated to a depth of 8 inches or more, and often mixed with earth from the adjoining slopes or from the underlying beds of clay and sand. The material often extends to a depth of many feet, though clay, gravel, or sand may be encountered anywhere from 8 inches to 3 feet.

The area of Muck which extends from Sand Lake to a point 5 miles east of Barnum is underlain by sand at from 8 to 18 inches. Another extensive area begins 1½ miles north of Barnum and extends northeast for a distance of 6 miles. It varies in width from one-fourth to 1 mile and includes practically all of sec. 29, T. 47, R. 18, from which it has been called "the swamp of 29." In this area the Muck is of great depth. The area of Muck that extends from the intersection of Otter Creek and the Northern Pacific Railroad to Atkinson is underlain, at

least throughout a part of its course,
by closely bedded stones and bowlde
an ancient outlet of Lake Superior, an
lated over the old stream channel.
Reservation are numerous Muck area

Throughout the Muck areas are a
with decaying vegetable matter whi
posed. This material should be class
areas is small and it was not practicab

The characteristic growth on the
cedar, and black ash, giving rise t
"tamarack," "cedar," and "black as
is continually covered with water, w
able for the growth above mention
sphagnum moss.

Over the greater part of the Muck
an advanced stage, and such areas w
producing large yields of specially ad
swampy areas could be drained by re
natural waterways. By deepening
structing a few open ditches thousand
it is not probable that any action wi
the country becomes more thickly
demand for farm land. At the head
has been cleared and drained, and 2 to
an average crop. No other crops ha
type, but oats and corn for fodder w
returns.

ROUGH STONY

The soil of the Rough stony land is
chiefly of a heavy sandy loam or lo
loam. The surface is generally rou
strewn with stones and bowlders tha
tural purposes. Small rock outcrops

Only 8 square miles of this type w
development is in the northeastern p
the more gentle slopes and a part of
overlook the valley of Lake Superio
low-lying area in which the stones are
can cross by stepping from one sto
occurs near the railroad, 2 miles above
are found in various parts of the surv

The Rough stony land may be use
poses, but further than this it is of n

MEADOW.

The type mapped as Meadow occupies the low, flat lands along streams and is subject to overflow in times of high water. The soil, which has been reworked by stream action, consists chiefly of a heavy loam and the subsoil is usually sand or gravel, though it is too variable to be classified with any of the other types mapped. The largest proportion of the type occurs along the Moosehorn River and Otter Creek. A large part of the Meadow is free from tree growth and considerable quantities of wild hay are cut each year. None of the type is under cultivation.

ROCK OUTCROP.

Extending northeast from Short Line Park, along the steep slope from the upland to the valley of Lake Superior, is a series of cliffs, ledges, and other areas too stony to be suited to any agricultural purpose. Similar areas of lesser extent occur between Thomson and Cloquet, and at a few other points along the St. Louis River and Otter Creek. The location of such areas has been indicated on the map by means of color, except where too small to appear on the map, in which case they have been included in the type with which they occur.

AGRICULTURAL CONDITIONS.

The agricultural interests of the area surveyed are still in the early stages of development. While only about 10 per cent of the land is now under cultivation, and while the sum total of the agricultural wealth is comparatively small, enough has been accomplished on the various soils now being tilled to demonstrate their ability to produce profitable crops, and thus make general farming in this region successful.

The greater proportion of the land within the area is now in the hands of real estate companies, which deal with the new settlers and sell to them "by contract." The land is selected and a small sum paid down. A contract is then made by which the purchaser agrees to pay the remainder in a specified number of installments. The companies are usually lenient, and in case of sickness or poor crops, and consequent inability to meet payments, the time is extended. When the last payment is made the purchaser is given a deed to the property.

Those who have been engaged in farming for a number of years are in a fairly prosperous condition. The buildings are substantially constructed and usually in good repair. About 90 per cent of the farms are operated by their owners, and only a small proportion of these have any incumbrance. The average size of farms is 85 acres.

But little difficulty is experienced in securing competent labor for the farm. The wages vary from $20 to $26 a month with board. During the winter months the farm hands secure employment in the lumber woods farther north at $30 a month.

Clearing the land and preparing it
task, the most expensive feature bei
The value of unimproved land varies
cost of removing the stumps equals an
purchase price. The pine stumps dec
an effective agent in removing them,
horse power is in common use. The
and will remove stumps of almost any
few can afford such an outfit.

Owing to the number of stumps and
the newly cleared fields, the method of
is necessary to use the scythe and crad
In the older communities, however, i
general use.

Hay has always been the principa
though wheat, oats, rye, barley, pot
adapted to this region. With the exc
these products is increasing each year.
is well adapted to the production of cl
out the "cut-over lands," along the c
old camps, and wherever seed have be
luxuriant growth of these plants. Tl
yields of 2 or 3 tons of hay per ac
and timothy are sown in the spring w
wild grasses are plentiful, and on the
streams where there is no underbrush
and cured each year. Throughout t
abundance of excellent pasture durin
brush were removed, good yields of h

But little wheat is grown within the
ern part yields of 25 bushels per acr
wheats seem to be less affected by ru
also produce larger yields. Wheat
cleared land until two or three other
soil becomes mellow. As a whole tl
extensive production of wheat, and tl
be limited at most to a supply for h
cleared area is small, and especially w
modern harvesting machinery, it is i
prairie sections in the growing of whe

On account of the extensive lumbe
northern part of the State there is a
demand will continue as long as the
do better on the newly cleared land t
favorable conditions a good yield m

Miami stony loam is well adapted to this crop, and the Miami sandy loam also produces fair yields. A few fields were seen on the Superior clay, and here the grain stood thick upon the ground and was making a vigorous growth. The Improved Ligowa and the "Minnesota No. 35" are two varieties which have been grown to some extent and seem to be better adapted to the soil and climate than other varieties. A loss of weight and a decrease in the yield sometimes occur when new varieties are first tried. Those which maintain their good qualities should be selected and an effort made to assist them in becoming adapted to this particular region. The oat crop is sown between May 5 and 20 and is harvested the latter part of August. It is sometimes possible to sow earlier than this, and when conditions are favorable this is advisable. The early sown grain has the advantage over that sown later in that it forms a better root system, is better able to resist drought later on, ripens earlier, and usually produces larger yields.

A small amount of barley is grown and is used mostly in feeding hogs. Potatoes and the various root crops yield very well on the light soils of the area. Truck farming should shortly develop into a profitable industry. Strawberries do especially well, and as they ripen after the southern supply is exhausted a good price can always be secured.

The conditions within the area are generally considered to be unfavorable for the production of corn. The growing season is comparatively short and the nights are usually cool. Although only a small amount of corn has been grown within the area, it has been demonstrated that by careful selection hardier and earlier maturing varieties can be developed. The smaller and hardier of the flint varieties are now being grown at Grand Rapids, Minn., which is still farther north, and it is believed that the same success may be attained in this region. Sweet corn matures within the area, and a small amount of field corn has been grown for fodder.

In order to maintain the productiveness of the soils, careful management will be necessary. No commercial fertilizers are used. The barnyard manure made during the winter is spread over the fields in the spring, but the supply is insufficient to cover the cultivated fields more than once in about five years. Oats and potatoes usually constitute the first crop grown on newly cleared land. Oats may be followed by grass, clover, and timothy sown with the grain in the spring. Wheat may follow the oats, though in no part of the area is there a fixed rotation of crops practiced. Sections most convenient and most easily cleared are usually selected without special note being taken of the character of the soil or its adaptation to crops to be grown.

Dairy farming gives promise of b
The wild grasses, together with the
luxuriantly over the greater proport
pasture throughout the summer an
shelter and feed the cattle for abou
an abundant supply of hay can be
small amount of ground feed, will ca
in good condition. The growing of
reduce the cost of feed and greatly
ply. The building of silos is to be re

A small creamery is in operation
num, just outside of the area. The
panies. The cream is purchased fro
ing with the butter-fat content. Te
with an average for the season of
amount of milk is brought into the t
try district, but the supply is in no

The transportation facilities of
demands of a thickly settled and hig
Northern Pacific Railroad and the
traverse the area and cross at Carl
Short Line passes through and con
St. Paul and Minneapolis, as does als
Railroad. Duluth and Superior, to
bering and mining towns in northea
market for large amounts of farm p
of this demand is supplied by the p

SOIL SURVEY OF PORTA(

By **F. N. MEEKER** and :

LOCATION AND BOUND.

Portage County is situated very
State of Wisconsin, and comprises
bounded on the north by Marathon
County, on the south by Waushara
west by Wood County. It is regul
square of five townships on each si
townships, 21, 22, and 23 N., R. 6
County.

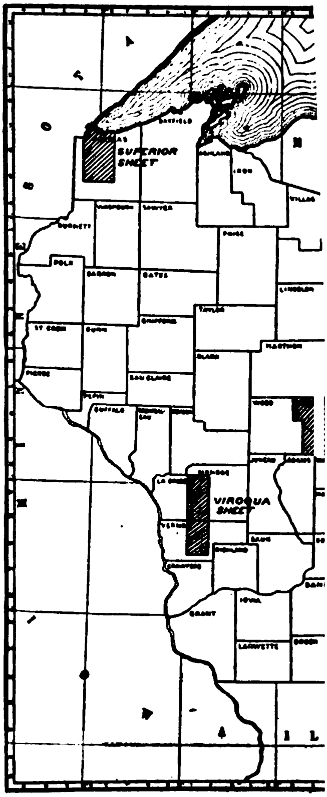

FIG. 35.—Sketch map showing location of th

The Wisconsin River, on which is lo
seat, traverses the northwestern part (
108 miles by rail from Madison and
base map used in the soil survey was t

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Portage County was organized in January, 1844, and at that time embraced a large part of the territory of northern Wisconsin. By later acts of the legislature several other counties were formed from what was originally Portage County. The last to be set off was Wood County, in 1856, leaving the area of Portage County within the constitutional limit.

In 1820 the area of the county, together with the whole of upper Wisconsin, was an unbroken wilderness. It, like several of the surrounding counties, was first visited by white man for its pine timber. The Indians became alarmed at the rapid increase of lumbermen, and complained to the Government agents. In 1836 a treaty was made with the Menominee Indians for the cession of a strip of land 3 miles in width on each side of the Wisconsin River, from Point Bas, 40 miles up the river, to permit the operations of the lumbermen. This was offered for public sale in 1840, which opened the country, to the extent of this strip, to occupation and settlement. Early records show that the first settlers came principally from Illinois, Ohio, Pennsylvania, New York, and Maine, and a few from Canada. At present quite a large proportion of the population of Portage County is made up of Poles, Germans, Norwegians, and Swedes, who moved here mostly between the years 1850 and 1870. Many of them emigrated directly from Europe, while others came from the Eastern and Central States.

As the lumbering industry increased a demand arose for some means of obtaining supplies at less cost than wagoning them from southern Wisconsin and northern Illinois. Early experiments in agriculture proved so successful that many men who came for the purpose of lumbering turned their attention to farming, selling their farm produce to the lumbermen.

In 1848 a treaty was concluded with the Menominee Indians by which the United States Government acquired all the land in the State belonging to this tribe. This opened the remaining part of Portage County to settlement. New settlers came in from States to the south and east, and immense tracts of pine and other lands were entered, which quickened the lumbering industry, as well as the farming industry, of this county. The principal crops grown by the early farmers were potatoes, corn, oats, rye, and wheat.

CLIMATE.

In general the climate of Portage County is very healthful, though subject to great extremes of temperature. The winters are usually long and severe, the temperature sometimes falling as low as —35° F. The soil freezes to a depth of from 1 to 3 feet. The snowfall is heavy and usually covers the ground from the 1st of December

to the middle of March. It is ne
tion for the housing of stock durin
mers are rather short, but very ple
ature reaches 100° F., thus giving a

The following table, compiled fi
Bureau stations at Stevens Point
monthly and annual temperature
The data here given are computed f
eleven years at Stevens Point and t

Normal monthly and annual te

Month.	Stevens Point.		Amherst.		
	Temperature.	Precipitation.	Temperature.	Precipitation.	
	° F.	*Inches.*	*° F.*	*Inches.*	
January	15.9	0.77	13.9	1.12	A
February	14.1	.75	14.4	1.73	S
March	28.3	1.26	27.7	1.75	O
April	47.0	2.50	44.5	2.74	N
May	57.6	4.13	55.5	4.23	D
June	66.2	3.70	65.4	4.24	
July	69.6	3.42	70.8	3.76	

It will be noted from the table tha
uted, about 70 per cent of the rain fa
30, the period of the year when veg
From the 1st of January until th
winds are from the west and nort
and June generally blow from the s
and August they usually blow from
last four months of the year the
northwest. During the months of J
storms are frequent, with occasio
nadoes and heavy hailstorms occu
killing frost in the fall usually occ
last in the spring about May 25.
approximately 122 days.

PHYSIOGRAPHY A

Portage County is from 1,200 to
northern part, slopes gently toward t
from 900 to 1,100 feet at the sout
from 500 to 600 feet above Lake Mic
the central part of Portage County t

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[a] Matters pertaining to the geology of
Geology of Wisconsin, by T. C. Chamberla

like. In the southern part of the county this level area is approximately 18 miles in width and extends northward along the western border of the county about as far north as the Wisconsin River. As it extends northward it becomes narrower, and on the northern boundary line is about 12 miles wide.

All of that portion of the country east of the plainlike area is part of a terminal moraine, and includes fully one-third of the county. Here the surface is for the most part very uneven, rounded or hummocky hills and bowlder ridges being prominent features of the topography, though in the eastern part of the country, in the vicinity of Alban, Newhope, and Garfield, are some level or slightly rolling areas. The boundary between the moraine and the more level area to the west of it is very distinct. The difference in elevation between these two areas is from 50 to 100 feet. The northwest part of Portage County has a level to rolling topography.

The principal river of the county is the Wisconsin, which flows from the north through the more level area of the central part of the county. On this river are located Stevens Point, Conant Rapids, and Plover. Both Little Eau Pleine and Plover rivers empty into the Wisconsin in this county. In the southwestern part of the county three creeks, Buena Vista, Duck, and Ten Mile, flow to the westward and empty into the Wisconsin River in Wood County. These drain the large swampy area in the southwestern part of the county. Mill Creek, another small stream tributary to the Wisconsin, drains the northwestern part of the area. The water of all of these eventually reaches the Mississippi River. East of the divide, passing north and south through the eastern part of the county, the Waupaca River and the Little Wolf River, with their many smaller tributaries reaching throughout almost the entire eastern part of the county, flow to the southeast and finally reach Lake Michigan.

Throughout the area of the moraine are to be found numerous small lakes, where water has accumulated in the depressions of the uneven surface. Some of these lakes have no surface outlet, while others have. Still other depressions which were originally lakes are now marshy or swampy areas. In some of the depressions the accumulated organic matter has so far decayed as to form a soil of the nature of peat or muck, or some intermediate stage between the two. The forest growth is mainly tamarack, with some cedar. These swampy areas among the moraine hills are all comparatively small. In the southwestern part of the county is a marshy area covering about 55,000 acres. Other small marshy areas are found scattered throughout the entire northwestern part of the county.

The eastern part of the county is a typical glacial area, its surface for the most part being made up of rounded drift hills and ridges. The area shows comparatively little evidence of erosion, which fact

would indicate that it originated t
from the later ice sheets which pa
Many kettle-hole depressions occur
portion of this county forms a par
Range, a range of moraine hills whi
tance to the north and south of Port
ing these drift deposits are bowld
being the most prominent material.
numbers in some parts of this distr
very few in number.

In the northwestern part of the c
material deposited by an ice flow
eastern part of the county. Bowlder
in such large numbers as in the ea
much more eroded, and the result
heavier than those of the eastern par

The next older geological formati
the Potsdam sandstone of the Cam
formation outcrops in a number of
western parts of the county, and is
over the older rocks beneath. In T
ledges or peaks of this sandstone ext
above the level of the surrounding
are found the crystalline rocks of Ar
stone in Portage County is comparat
Stevens Point the crystalline rocks
river at this point is also to be seen
stone. The Archean rocks can be
south in the river bed until at Nekoos
entirely covered by the sandstone. N
of the sandstone is seen, while the
surface in several places, and prob
portion of the northwestern part of
short distance below the surface. T
gneisses and granites. The heavier
seem to have originated both from th
ing crystalline rocks and the overlyin

During the closing stages of the l
was gradually melting, the streams iss
much swollen, and were thus able to c
of materials along their courses. In
more level area of the central and
County has been formed. Along ce
raines is an "outwash" plain forme
melting glacier. Over these areas

quite coarse gravel, and are usually heavier than the alluvial soils farther west. The soils of the glacial outwash plain and those of the river flood plain merge into each other so imperceptibly that it is impossible to note any sharp dividing line between the two.[a]

SOILS.

Twelve soil types have been recognized in this area, including Muck and the bottom-land soil along the streams. In many places the types pass so gradually one into another that it is difficult to define their boundaries, while in other parts of the area the boundaries are sharply marked. The map accompanying this report represents the types in color, while the extent of each is shown by the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Miami sand	146,624	28.7	**Miami stony sand**	17,536	3.4
Muck	128,640	25.2	**Portage stony sandy loam**	11,392	2.2
Miami sandy loam	65,536	12.8	**Portage sandy loam**	9,792	2.0
Miami loam	44,544	8.8	**Miami stony loam**	5,632	1.1
Marshall sand	31,040	6.1	**Wabash loam**	2,944	.6
Marshall gravelly loam	24,064	4.7	Total	510,400	
Portage silt loam	22,656	4.4			

MIAMI SAND.

The Miami sand occupies 28.7 per cent of the area of the county, and is one of the most extensive soil types of the area. The surface material, to a depth of 7 to 9 inches, is a brown medium sand, composed mainly of somewhat rounded particles. The sand often has a loamy appearance, especially in cultivated areas, owing to the presence of more silt, clay, and organic material. In local areas the first 1 or 2 inches of the soil may be somewhat darker than the type in general, this being due to the increased amount of organic material near the surface. The subsoil is almost invariably a yellowish-brown medium sand, becoming somewhat lighter in color and coarser in texture as the depth increases. Fine gravel is sometimes found in the subsoil, usually at a depth of from 25 to 36 inches. Where the Miami sand occurs in the area of the moraine in the eastern part of the county, it is not uncommon to find gravel in the subsoil and sometimes in the soil.

This type of soil occurs most largely in the southern part although it is also found in separate areas in nearly all parts of the county. Its surface in the moraine district is rolling and hilly. In the southwestern part of the area, where the type occurs on the Wis-

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[a] Soils and agricultural conditions of north-central Wisconsin, by Doctor Samuel Weidmann, p. 6.

The results of the determinations made on this soil by the wire-basket method indicate that stable manure produces large increases in the productiveness of the soil; that nitrate of soda exerts a beneficial effect, which is further augmented by the addition of acid phosphate, sulphate of potash, and lime, although no two of these substances in combination have any advantages over nitrate of soda alone. The results agree with field practice and experience in regard to stable manure, and suggest that nitrate of soda and complete fertilizers with lime might prove of decided benefit.

In these tests wheat plants were used as an indicator, and the results are held to be applicable only to the field from which the sample was taken and to related crops. To what extent they are applicable to potatoes or other unrelated crops is a matter for further investigation.

MIAMI SANDY LOAM.

The Miami sandy loam is composed of a brown, somewhat loose medium sandy loam, about 8 inches deep, underlain by a yellowish-brown light sandy loam, which may become a sticky sandy loam as depth increases, and sometimes contains a sufficient amount of stone and gravel to make borings difficult. At a depth of about 27 inches the subsoil generally grades into a mixture of sand and gravel which continues to a depth of 36 inches or more. A yellowish sandy clay frequently occurs at a depth of from 20 to 25 inches. This may grade into a mixture of sand and gravel or into sandy clay which contains gravel. Over the small areas of the type in the moraine district stone and bowlders occur quite plentifully on the surface, but the extent of such occurrences is not sufficient to warrant the establishment of a distinct type. This stony phase is indicated on the map by symbol.

This type occurs in irregular shaped areas in the eastern, northwestern, and south-central parts of the county. In the latter section the topography is quite level or gently rolling. North of Almond some quite level areas occur. In the region of the moraine, as well as in the northwestern part of the county, the topography is rolling and hilly. Owing to the surface configuration of the type and to its texture it is usually very well drained, while at the same time it retains sufficient moisture to prevent injury to crops during ordinary dry spells.

In the eastern part of the county the Miami sandy loam is made up of drift material deposited by the later glaciers, while in the northwestern part of the county it is probably very largely derived from material laid down by an earlier ice sheet. The parts of the type occurring on the more level areas in the south-central part of the

county undoubtedly have origina
the east, transported by the water

The potato is the crop to which t
oats, rye, and hay are also grow
bushels per acre, corn from 25 to 3
els, rye from 15 to 20 bushels, an
This type as a whole is not conside
attention is given to fertilizing an
may be counted upon. Oak is the
type.

The Miami sandy loam has a val

The following table shows the av
ses of typical samples of the soil an

Mechanical analyses o

Number.	Description.	Fine gravel.	Coarse sand.
		Per cent.	*Per cent.*
13275, 13888, 13892.	Soil........	0.8	12.6
13276, 13889, 13893.	Subsoil....	1.5	9.3

A large sample of this type was c
ing an idea of its principal manur
situated about 1 mile northeast of
of brown sandy loam about 9 inch
fragments. The surface is gently r
The land from which the sample w
twenty-three years, cropped to grass
less regular rotation. Medium yiel
good yields of corn and potatoes ar
light applications of stable manure,

The results obtained by the wir
fair increase in productiveness may
that a complete fertilizer with lime
When lime alone was used it seemed
nection with some other fertilizer i
ficial effects to some extent. When
of potash, or acid phosphate was use
observed, but when any two of the
a slight increase in yield occurred.

These results were obtained by th
cator. To what extent they are app
fields than that from which the s
determined.

MIAMI STONY SAND.

The upper 7 or 8 inches of the Miami stony sand consist of a rather light-brown fine to medium sand, containing varying amounts of small stone and gravel. The surface is usually quite thickly strewn with bowlders. The subsoil is a yellowish-brown fine to medium sand, which becomes somewhat lighter in color as the depth increases. It also contains varying amounts of small stone and gravel.

The type is located in the eastern part of the county, the largest areas being found in the south-central part, a little to the east of a line drawn north and south through the center of the county. It occupies only a small part of the area surveyed and occurs in quite widely separated, long, narrow areas, often forming ridges which have in general a north and south direction. On these ridges bowlders of all sizes are often found, and the proportion of stones is in general greater than in other parts of the type. The topography of the Miami stony sand is the most rolling and uneven of any type of the area, the hills and ridges usually being from 50 to 100 feet above the lower lying areas to the west. Owing to its surface configuration and to the texture of both the soil and subsoil the type is always well drained. Wherever small areas of the type are cultivated they are inclined to be droughty.

The origin of this type is very similar to that of the Miami sand found in the eastern part of the county, the sand being derived largely from the grinding up of Potsdam formation. The crystalline bowlders scattered through the soil have been carried here by the glacier from the region farther to the north and northeast.

The Miami stony sand is used almost entirely for grazing, for which purpose it is best adapted. Wherever any of this type is cultivated, the crops grown and the yields obtained are similar to those on the Miami sand. In most cases the bowlders are so large that it is impracticable to attempt to remove them from the fields. A large part of the type is covered with forest growth, mainly red and white oak. The Miami stony sand has a value of from $20 to $25 an acre.

The following table gives the average results of mechanical analyses of typical samples of this type of soil:

Mechanical analyses of Miami stony sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13610, 13918	Soil	1.7	11.6	19.1	43.1	8.1	10.1	5.8
13611, 13919	Subsoil	1.7	11.8	19.2	44.4	7.9	9.2	5.4

For the purpose of making a wire-basket test of the manurial requirements of this type of soil a large sample was collected about 9

miles east of Stevens Point. The soil
a brown light sandy loam, containing
soil, but large quantities of bowlders a
open structure tends to make the land
a result depressions receiving wash an
productive than the higher lying land.

The field from which the sample wa
moraine and has been in cultivation f
potatoes, oats, and grass forming the c
last two are very light. No definite in
duction of the others could be obtained.

The results of the determinations m
this soil is benefited to a marked deg
manure; that nitrate of soda and sulph
increases, which are more marked wh
and that acid phosphate, lime, and gre
in increasing the productiveness.

In these tests wheat was used as the i
conditions of climate and moisture mai
These results are held to be applicable
the sample was taken, but the treatmen
a considerable part of the type as it occ

MARSHALL SA

The Marshall sand is quite distinct
upper 9 to 11 inches consist of a dark
containing a small percentage of silt an
to the organic matter contained. This
tent of silt and clay, gives the soil it
especially noticeable in slight depress
the sand grains are seen to be consider
a very loose yellowish-brown sand, n
somewhat lighter in color and coarse
creases. A small amount of fine gravel
30 to 36 inches. The subsoil of this t
form of any occurring in the area.
is due to the very small amount of iron
are to be found on the surface of the ty

Almost the entire area of this type
Wisconsin River, occurring on the br
The southern boundary of the type is
Plover, from which point it extends no
but almost unbroken area to the coun
the area reaches about 5 miles to the
isolated areas of the type in other part
southwestern part, around the edge of t

One of the very noticeable features of this type is its level topography. Although level it is well drained, owing to the loose and porous nature of both the soil and subsoil. During wet seasons crops do fairly well, but during seasons of average rain or during dry seasons crops are very likely to suffer for lack of moisture.

The material composing this type of soil was undoubtedly deposited during the later stage of the glacial period, when the streams issuing from the glaciers were very much swollen and were able to carry large amounts of material. About 2 miles east of Stevens Point, where the Plover River has cut its channel through this type, the deep subsoil is seen to be very sandy. The principal constituent of both the soil and subsoil is quartz sand. Owing to the nature of the soil, the roads passing over the type are usually very sandy. This has occasioned so much difficulty in traveling that parts of three of the main roads leading from Stevens Point have been covered with crushed rock, thus making a very firm roadbed.

The potato is the crop which seems best adapted to this soil. Corn grows fairly well. Clover catches and grows quite well during seasons of sufficient rain. Rye and oats are also grown on the type. Potatoes commonly yield from 75 to 125 bushels per acre, corn from 20 to 25 bushels, rye from 10 to 12 bushels, and oats about 25 bushels to the acre. Hay produces from one-half to 1 ton per acre. From about 1860 to 1880 large quantities of hops were produced on this type of soil, but at present very few are grown.

Under improved conditions farms on the Marshall sand are worth about $40 an acre, while in its wild state the type is worth from $10 to $20 an acre. The principal forest growth over the type is oak and jack pine.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Marshall sand:

Mechanical analyses of Marshall sand.

Number.	Description.	Fine gravel.	Coarse. sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13271, 13912	Soil	0.8	17.1	25.7	37.2	4.5	6.1	8.3
13272, 13913	Subsoil	1.4	18.0	30.9	38.6	4.1	3.2	3.7

With a view of determining its principal manurial requirements, a large sample of this type was collected about 1 mile southeast of Stevens Point. The field from which the sample was taken had been in cultivation for more than twenty-five years, during which time no fertilizers and only moderate quantities of stable manure had been used. The soil is used mainly in the production of potatoes, yielding 100 to 150 bushels per acre. Barley, oats, rye, and grass are grown. Poor crops of grass, mainly red-top, are secured.

The results obtained on this soil b
cate that stable manure produces a
that nitrate of soda is also quite bene
sulphate of potash, lime, and green n
In these tests wheat plants were use
extent these results would apply to
determined.

The indications as to the use of sta
in agreement with field practice and
would doubtless be of value, particula
The results are held to be applicable
sample was taken, but will doubtless
of the type in similar condition.

MIAMI LO

The surface soil of the Miami loam
dark-brown, rather compact loam com
sand, the sand being mostly fine to
also some clay in the soil, which, to
gives it quite a mellow texture. Th
18 inches, is a yellowish-brown loa
soil, composed mainly of silt and
a depth of about 25 inches usually o
sandy clay, often containing small
this is generally to be found a mixt
stones. Bowlders are found here and
in sufficient numbers to interfere se
stones and bowlders have in some cas

This type is located in the eastern
areas lying in T. 23 and 24 N., R.
is on the eastern side of the draina
north and south through the eastern

The topography of the type is both
and in the northern part of T. 23 N., R
level or only slightly rolling surface.
R. 10 E., is another noticeably level
the type are generally quite rolling.

The Miami loam is well drained,
ample moisture for the growing of go
affected either by prolonged dry wea
wet weather. All of this type is foun
is undoubtedly of glacial origin. The
from the Archean crystalline rocks wh

The Miami loam is one of the best
well adapted to general farming pu

strawberries and raspberries, do well on the type. Apple trees as a usual thing do not thrive in this county, although on some parts of this type they seem to grow and produce well. The crab apple seems to grow better than other varieties. On this soil potatoes produce from 100 to 150 bushels per acre, corn from 30 to 40 bushels, and hay from 1½ to 2 tons per acre. Oats yield from 40 to 50 bushels and rye about 20 bushels per acre. The soil has a value of from $30 to $50 an acre.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Miami loam:

Mechanical analyses of Miami loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13285, 13898, 13900.	Soil	1.8	12.7	13.3	14.2	6.9	38.4	12.7
13286, 13899, 13901.	Subsoil	2.7	15.4	13.8	17.1	7.2	26.6	17.0

MARSHALL GRAVELLY LOAM.

The upper 9 to 11 inches of Marshall gravelly loam consist of a dark-brown to black medium sandy loam. Gravel and small stones may occur on the surface and disseminated through the soil, but this is not always the case. Over a good part of the type as it occurs in this county this feature is absent, and in parts of the type the soil is quite silty. The immediate subsoil varies from a sand to a yellowish-brown or dark-brown sandy loam. At a depth of from 20 to 24 inches is generally a sticky sand or sandy clay of a yellowish-brown color, containing varying proportions of small stones and gravel. This gravel content of the subsoil is practically a constant feature of the type. Below a depth of about 30 inches the subsoil is generally lighter, usually being made up of a mixture of rather coarse yellowish-brown sticky sand and gravel.

The largest area of this type occurs northeast of the central part of the county, most of it between Ellis and Stockton. Another area occurs in the northeastern part of the county in the vicinity of Rosholt and Alban, and a third area is found near Almond. That part of the type around Rosholt is within the limits of the terminal moraine, but has a level to gently rolling topography. The remainder of the type occupies parts of the more level area passing nearly north and south through the county, and locally known as "the prairie."

The type is well drained and is a good farming soil. It retains moisture much better than the lighter soils of the area, and thus the crop yields are much more certain. The greater part of the type is under cultivation. Many well-kept farms are to be seen on it, and nearly all the houses and barns are well built and in good repair.

That part of the type occurring a
origin. The remaining areas of the
the outwash plain formed by water is
ing glacier. In some parts of the typ
erably darker than that of the type
amount of organic material.

More hops are produced at present
other in the county. For some years
tion have been so low that it has no
At present, however, there seems to be
so that the chances for profitable retu
ably better. The soil of this type se
crop. Some of the hops produced on
be equal to the best European hops.
to the acre, although under favorabl
very much increased. Potatoes and h
the type. Potatoes yield from 100 t
about 1½ tons to the acre. Corn, oats,
fully, corn producing about 35 bushel
els, and rye about 18 bushels. The ty
to $50 an acre.

The following table gives the avera
ses of typical samples of the Marshal

Mechanical analyses of Ma

Number.	Description.	Fine gravel.	Coarse sand.	Me s
		Per cent.	*Per cent.*	*Per*
13269, 13902	Soil	2.6	18.8	
13270, 13903	Subsoil	2.2	16.1	

In order to obtain an idea of the
type, a large sample was collected fr
of Ellis. This field had been in cul
crops grown being potatoes, oats, rye,
and grain are secured. Potatoes yie
acre. Little corn is grown on this f
manure are used on potatoes, but no c
crop.

The manurial requirements of this
basket method, are as follows: Stable
productiveness; nitrate of soda is sli
and lime, also acid phosphate, sulpha
in combination, produce no improvem

These results are obtained with whe
to be applicable strictly only to the fi

taken and are not to be considered as final for all crops even there. They are, however, in agreement with general farm practice on this type, and may prove of value over considerable areas of this soil in the county.

MIAMI STONY LOAM.

The surface soil of the Miami stony loam consists of a dark-brown to rather black loam 4 to 6 inches deep, composed mainly of silt and fine sand. It contains considerable quantities of stones and gravel, and over the surface are usually strewn large numbers of bowlders. The subsoil is generally a yellowish loam, composed mainly of silt and fine sand, which at about 18 inches grades into a sandy clay, continuing to a depth of about 25 inches. Below this is usually found a mixture of sand and gravel, the sand sometimes being sticky. The making of borings is often rendered difficult by the stones in the subsoil. This type of soil is quite similar to the Miami loam, except that it has a great many more bowlders strewn over its surface. The soil of the Miami stony loam is also shallower and is somewhat darker in color than that of the Miami loam, on account of the larger proportion of organic material which it contains.

The Miami stony loam is located entirely within the limits of the terminal moraine in the eastern and northeastern parts of the county. It covers only a small proportion of the survey and occurs in comparatively small isolated areas. The topography is usually quite rough and rolling, and the type sometimes occurs on ridges. Owing to its surface configuration the soil is well drained. The nature of the soil, however, is such that it retains moisture well.

Its origin is very similar to that of the Miami loam. The large bowlders, for the most part granite, found on this type were originally a part of the Archean rocks which underlie this section of the State. The soil is composed mainly of fine-grained quartz sand, together with considerable silt and clay.

The Miami stony loam is used almost entirely for grazing purposes, to which it is adapted. The bowlders are usually so large that it is impracticable to remove them from the fields. The greater part of the type is covered with a forest growth, principally of oak. Its value varies from $15 to $25 an acre.

The following table gives the average results of mechanical analyses of typical samples of fine earth of the soil and subsoil of the stony loam:

Mechanical analyses of Miami stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13283, 13908	Soil	1.8	12.1	14.1	15.5	6.6	39.3	10.3
13284, 13909	Subsoil	2.4	13.7	15.8	23.3	7.6	21.7	15.3

POR

The upper 8 or 10 inches
grayish colored silty loam, u
yellow heavy loam composed
about 25 inches a thin layer
quently occurs, grading quit
which continues to a depth o
part of T. 24 N., R. 6 E., an
R. 6 E., is a phase of this soi
contain somewhat less clay.
occurs at a depth of about 3
phase is also to be found in th
this particular area the lower

The Portage silt loam is f
west and northwest from Ste
is quite level, but some of t
tion are slightly rolling. M
poorly drained, and several
Considerable improvement co
of open ditches to connect w
rolling phases of the type are,

The materials composing t
three different sources. The
underlying crystalline rocks;
face covering of silty material

The type is naturally pro
requires deep and thorough
turned under not only for
matter content, but also to im
The Portage silt loam is well
and small fruits, such as str
also do well. Both corn and
phases of the type. Hay pro
bushels, oats from 40 to 50 bu
about 125 bushels to the acre.
fairly well and produces abou
from 20 to 30 bushels per acre.

The principal forest growt
and elm. Land of this type
an acre, depending upon impr

The following table gives the average results of mechanical analyses of samples of the Portage silt loam:

Mechanical analyses of Portage silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13931, 13930, 13934.	Soil	1.0	4.9	3.5	4.1	5.5	57.8	23.0
13936	Subsoil	.9	16.9	20.1	28.4	5.4	11.6	16.4
13937	do	.6	6.5	7.5	14.1	5.6	25.0	40.4

In order to obtain an idea of the manurial requirements of this soil a large sample was collected about 1 mile southwest of Junction. In the field from which the sample was taken the soil has a depth of about 8 inches, and consists of a heavy brown silt loam containing some shale fragments. The subsoil is a silty clay, but considering its heavy texture the type has fair drainage. The field has been in cultivation over twenty years, cropped to grass, corn, oats, and barley. The yield of grain ranges medium to good, and of grass from 2 to 3 tons per acre of fine quality hay. Some stable manure is used, but no other fertilizer.

The wire-basket tests indicate that stable manure produces a fair increase in productiveness, and that lime has a slightly beneficial effect, while nitrate of soda, sulphate of potash, and acid phosphate, alone or in combination, have little or no effect. These results are held to be applicable only to the field from which the sample was taken. They are, however, in accord with the experience and practice of the community, and show the slight value of mineral fertilizers for general farm crops on a soil already in a high state of productiveness. Doubtless these indications will hold for considerable areas of this type in the vicinity, as the conditions of soil drainage and cultivation are apparently quite uniform.

PORTAGE SANDY LOAM.

The upper 8 or 9 inches of Portage sandy loam consist of a grayish-brown sandy loam of medium texture. Over the surface and through the soil are found varying quantities of small stones from 1 to 4 inches in diameter. The subsoil is generally a brownish-yellow sandy loam, which at a depth of from 20 to 25 inches usually grades into a sandy clay of mottled gray and yellow color. At a lower depth the sandy clay becomes redder in color and more compact.

This type occupies only 2 per cent of the area surveyed, and occurs in a number of small, irregular-shaped areas in the northwestern part of the county. The topography varies from gently rolling to nearly level. On the level areas the drainage is not good and considerable

improvement could be made l
with the natural drainage cl
areas are often to be found n

The lower subsoil of the I
underlying crystalline rocks
The surface soil has its origi
constituent of the type is qu
of Stevens Point the sandy cl
manufacture of brick.

This soil is quite well adapt
Hay is the most important cr
well. A large part of the ty
of hay is from 1 to 1½ tons p
about 30 bushels, oats about 4
Field peas are also grown wi

The principal forest grow
with some elm and ash. Th
acre.

The following table gives t
of samples of the Portage san

PORTAGE

Number.	Description.	Fine gravel.
		Per cent.
13279, 13942, 13944.	Soil	2.1
13280, 13943, 13945.	Subsoil	1.6

PORTAGE

The soil of the Portage s
grayish-brown medium sand
inches. The underlying ma
of fine to medium texture.
mottled yellow and gray sa
the type to a depth of 6 feet
tinues to a depth of 5½ feet,
brown sand. The sandy cl
Over the surface of this ty
crops of the underlying crys
of bowlders, principally of
subsoil.

The type lies entirely in th
area occurring between Wisc
varies from generally level
being quite level. As a resul

swampy depressions occur over the type. These would seem to be very difficult of drainage.

The origin of this type of soil is probably both glacial and residual, principally the former. It is composed principally of quartz sand. The bowlders and rock exposures are mostly granite.

Owing to the drainage conditions and to the quantity of stone, the Portage stony sandy loam is used for little else than pasturage. A large proportion of it supports a thick growth of oak, maple, and white birch, with a few scattering pines. The undergrowth in the poorly drained areas is mainly alder and willow. The valuation of the land of this type ranges from $15 to $25 per acre.

The following table gives the average results of mechanical analyses of samples of the fine earth of Portage stony sandy loam:

Mechanical analyses of Portage stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13277, 13968	Soil	1.5	11.2	21.9	35.6	9.2	12.1	8.3
13278, 13969	Subsoil	1.4	9.7	21.1	41.3	9.7	8.5	7.9

WABASH LOAM.

The Wabash loam is a stream-bottom type. The soil is a dark-brown somewhat heavy silty to sandy loam extending to a depth of about 10 inches. The subsoil is a dark yellowish-brown compact loam composed mainly of silt and fine sand. A dark yellowish-brown fine sand frequently occurs at a depth of about 25 inches, and fine gravel is sometimes found at a depth of about 3 feet. The type occurs only along the Wisconsin River and occupies a comparatively small area. It is quite level, in some places rather poorly drained, and is subject to overflow at least once in five years. But for this fact the Wabash loam would be a more desirable soil than it is at present. When the river is at its normal stage a large proportion of it is sufficiently well drained to produce good crops.

The soil type owes its origin to the recent deposition of material by the Wisconsin River during times of flood. It is naturally a very productive soil. While the occasional floods do great damage, at the same time they add fertilizing material to the soil and increase its crop-producing power. The Wabash loam seems to be best adapted to the growing of onions. Vegetables and small fruits also do well. Hay, corn, potatoes, oats, and rye are also grown. Hay is a good crop to grow on this soil, since it is not so likely to be injured by floods. Rye and oats, though grown to some extent, do not seem to be especially adapted to it, the straw being very rank and the grain not maturing well. Under average conditions onions produce about 400 bushels to the acre. Hay produces from 1 to 1½ tons to the acre, corn about 35 bushels, and potatoes from 125 to 175 bushels. Oats produce about 40 bushels to the acre and rye about 18 bushels. This soil type has an average value of about $30 an acre.

The following table gives the average results of mechanical analyses of samples of the Wabash loam:

Mechanical analyses of Wabash loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13267, 13884, 13886.	Soil	0.3	2.9	8.7	18.7	14.6	32.4	22.1
13268, 13885, 13887.	Subsoil	.3	3.1	11.4	42.2	14.8	17.2	10.9

MUCK.

The organic matter, in varying stages of decomposition, accumulated in the lower lying areas constitutes the material which has been mapped as Muck in this area. For the most part the soil is a black Muck, composed of finely divided and quite thoroughly decomposed vegetable matter, varying in depth from 1 to 6 feet or more. Sometimes the decomposition has not progressed far enough to produce a true Muck, thus giving rise to a soil more of the nature of Peat. This, however, seems to be the exception. The subsoil is usually a dark-gray sand of medium texture, but may also be a dark-gray sandy clay.

Some areas of the Muck are to be found in the eastern part of the county within the limits of the terminal moraine. These areas are insignificant when compared with the areas found in the western half of the county. In the southwestern part of the county are swampy or marshy areas which in the aggregate cover very nearly 100 square miles. In the northwestern and northern parts of the county are extensive Muck areas. In many cases, as will be seen by reference to the soil map, this type of soil lies along stream courses.

The areas of Muck are uniformly level and consequently poorly drained. Both soil and subsoil are usually saturated with water or have water standing on the surface. Only a few instances have been noted in this county this season where it has been possible to walk over the Muck areas without encountering water. Owing to its undrained condition these areas are locally spoken of as "swamps" or "marshes." Artificial drainage is necessary before this type of soil can be utilized for general farming purposes. Drainage work is at present being carried on in the southwestern part of the county.

The greater part of these areas is covered with a thick growth of coarse grasses, while in some areas a coarse moss is found. Many parts of the areas are treeless, supporting no other vegetation than the grasses, and still other areas are covered with a thick growth of poplar, willow, or tamarack. The latter is especially characteristic of the Muck areas in the northern part of the county, which are locally known as "tamarack swamps."

When thoroughly drained and brought under cultivation this soil should produce good crops of corn and potatoes. It is especially adapted to the growing of celery, onions, and cabbage. In other localities onions have been made to produce from 500 to 800 bushels to the acre on Muck soil. In both Michigan and Indiana peppermint is also a very successful crop for Muck. Even after drainage and cultivation the danger from frosts is considerably greater than on the upland soils. For this reason the Muck is better adapted to the growing of grass crops, since they require a great deal of water and are not affected by frost. Among the grasses which have been found to do well are timothy, redtop, and brome grass; alsike clover also thrives.

At present the Muck is utilized for little else than wild hay. In the spring of the year the areas are usually very wet, but during a part of July and August they are dry enough to allow the hay to be cut, though it can not be hauled away until late in the fall or early in winter, after the soil is frozen. The average yield is from 1 to 1½ tons to the acre. At present this type of soil is worth from $3 to $8 an acre.

In order to study the manurial requirements of this soil a sample was collected from the Portage County drainage district tract and an examination made by the wire-basket method. The results obtained indicate that this soil responds favorably to all the fertilizers which were tried. Manure or acid phosphate alone or in combination with sulphate of potash resulted in a marked improvement in productiveness. Sulphate of potash alone or in combination with nitrate of soda or with lime gave a fair increase, while an increase equally good was secured by mixing equal parts of the marsh soil and poor Cecil clay. Lime alone or nitrate of soda alone gave a small increase.

In these tests wheat plants were used as an indicator, and the results are not held to be applicable to other and unrelated crops.

RECLAMATION OF SWAMP LANDS.

In the southeastern part of the county is an extensive marshy muck area, occurring, as will be seen by reference to the soil map, in one large area and locally known as "Buena Vista Marsh." Through it are some smaller higher-lying areas of Miami sand.

Arrangements have been made, and are now being carried out, to drain the main part of this marsh. A district known as the "Portage County Drainage District," including about 55,000 acres, has

been established within the ar
area by the digging of six ma
to carry the water westward
Each of these creeks flows fr
Wisconsin River. Five of the
parallel with each other east
miles apart. The two main
are to empty into Ten Mile C
north, with one lateral, are t
average fall is about 3 feet to
feet wide and about 6½ feet de

The landowners within the
of drainage. In order to de
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marsh" lands. Otherwise th
character of the soil and sul
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where it comes in contact wit
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will be improved as rapidly
has been completed.

West of the town of Plover
paratively small Muck area
Drainage work is also being
being dug.

In the extreme northwester
and to the south of Eau Ple
a part of what is locally spo
have been made to carry out
the present time very little
drainage work has been done.

AGRICU

The potato is the principal
measure crop methods are ad

the land is plowed about June 1 to a depth of about 7 inches. It is then dragged and marked in check rows about 3 feet apart. Planting is done either with a hand or a horse planter. By the use of the hand planter from 2 to 3 acres can be planted in a day. On some of the larger farms where a planter operated by horsepower is used from 7 to 8 acres can be planted in a day. It is a difficult matter, however, to plant in check rows with this implement. As soon as the potato plants begin to show above the ground the field is harrowed thoroughly, which serves to rid it of small weeds and at the same time loosens the soil. As soon as it is possible to follow the rows cultivation is begun, for which purpose the sulky cultivator is generally used. The crop is cultivated from 3 to 4 times during the season, and little or no hoeing is done. For ridding the vines of potato bugs both large sprayers, operated by horsepower, and small hand sprayers are used. In some cases the larger implements work very successfully, but in general the hand sprayers seem to give the most satisfactory results. The potatoes are mostly dug during September. For this purpose a potato digger, of which there are several kinds, is generally used. With one of these implements from 3 to 5 acres can be dug in a day. The principal varieties raised are Burbank, Hebron, Rural New Yorker, Peerless, Early Ohio, and Triumph, the last named being sold mostly for southern seed. In many cases the crop is hauled directly from the field to the local market, where it is either stored or sold. Arrangements are usually made for storing at a certain rate per pushel, depending somewhat on the length of time of storage. Farmers living at a distance from local markets store their potatoes at home, either in pits in the field or in storehouses constructed for the purpose. At every railroad station are to be found one or more potato buyers. Most of the potatoes produced in this area are shipped to the Central and Eastern States.

Corn is generally planted during the latter part of the month of May. The rows are placed about 3½ feet apart. Some farmers plant in drills, but the majority plant in check rows, so that the corn can be cultivated both ways. In planting, either a hand planter or a horse planter is used. With the former about 6 acres can be planted in a day, and with the latter from 12 to 15 acres in a day. Just before the corn comes up it is a common practice to harrow the field at least twice for the purpose of getting rid of the weeds and loosening the soil. The best farmers consider the work of harrowing at this time very important. From this time on the field is usually cultivated four times, and little or no hoeing is done. The corn is cut during the latter part of August or the fore part of September. A great many farmers use corn binders for doing this work, with which from 7 to 10 acres can be cut in a day. Many, however, still use the old-fashioned corn knife, while a few use what is locally called a "stoneboat" corncutter. This is a low wooden frame, on each side of

which is attached a long, sha
at an angle. The frame is d
knife cutting one row of co
acres of corn in a day. Qui
area own corn huskers or shre

For oats the plowing is d
sown during the latter part
the early oats seem less likely
vested in the early part of Au

On both the Marshall sand
must be exercised in prepa
grains, not to work it into su
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surface soil is often so shifte
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While no well-defined syste
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fairly good. The crops gro
from time to time the field is
of farmers, however, some de
Quite commonly it is as fol
grain (wheat, oats, or rye)
For the following year's cro
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cial fertilizer is used. A cor
western part of the county, i
and shipped out of the count
county is, for the most part,

AGRICUL

Taken as a whole, the farm
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well built and well cared for
are often large enough to aff
housing the stock during the
the county has developed ra
siderably in value. In the
real estate and personal pro
county records. For the ye
year property was assessed
assessed for only one-third
total value of real estate and
fourteen years was $2,641,13
number of acres in farms in t
acres were improved. The

land, buildings, live stock, and domestic animals, was about $3,000. The price of land, with the exception of marsh or muck, generally varies from $20 to $50 an acre, and in some cases is said to be as high as $75 an acre. The Muck areas are at present worth from about $3 to $8 an acre. The average value of upland still covered with forest growth is probably about $20 an acre.

About 15 per cent of the farms are worked by tenants, the greater part of whom rent on a share basis. If the tenant furnishes team, seed, and tools he usually has two-thirds of the crop, but if the owner furnishes team, seed, and tools, each has one-half the crop. Land rents on a cash basis for from $1.50 to $3 an acre. The average sized farm is about 124 acres, but the farms vary in size from 40 to 400 acres. About nine out of ten farms are operated by the owners.

The farm laborers are all white, and, as a rule, can be had in sufficient numbers at a monthly wage of $18 to $25. In the northeastern part of the county the only laborers to be had are Poles, many of whom are not skilled in farm work. The amount which the average farmer pays out annually for hired help is comparatively small. The use of improved machinery has in many cases made it possible for the farmer to do without other help than that of his own family, except during the busiest season of the year. During the thrashing season or potato-digging time all the help needed can generally be had at $1.50 a day.

The potato is the principal product of the area. The industry of growing this crop for shipping purposes has developed almost entirely within the last two decades. Formerly wheat and hops, especially the latter, were much more important crops than they are at the present time. In the year 1885 the production of potatoes was 382,091 bushels, wheat 175,744 bushels, and hops 155,367 pounds. During the season of 1904 the production of potatoes was 2,993,885 bushels, wheat 11,568 bushels, and hops 12,100 pounds. Portage County leads all the other counties in the State in the production of potatoes.

The greater part of the farms are devoted to general farming, and comparatively little trucking or market gardening is done. The principal crops other than potatoes are hay, corn, rye, and oats. Some wheat, barley, and hops, with some cabbage, turnips, and onions, are also grown. Small fruits, such as raspberries and blackberries, grow very well in many parts of the county. The apple is about the only tree fruit which is grown in the area, and it does not thrive on most of the soils, as they are too sandy. Hay is an important crop. During most seasons a great many tons are cut from the marshes, besides that produced on the upland soils.

Another important agricultural industry in the county is dairying. Nearly every farm has a small herd of dairy cattle. There are about twenty creameries in the county and one or two cheese factories, most

of them having been established wi
As a rule the farmers who patroniz
returns. In many cases the farme
milk at home by use of a hand sep
statistics submitted to the county bo
ber of cows contributary to the crea
of money received from the sale of c
was $276,571.61, or $38.38 to the cow

Of the twelve types of soil foun
sand is probably the least producti
The potato is the crop to which the
careful attention is given to manuri
be obtained. In order to prevent
soil, it is necessary to pay special
crops as clover or peas, and to manu

The Miami sandy loam is only a
proportion of this type also requires
tilizing and crop rotation. Where
yields are usually good. The crop
is the potato.

The Miami stony sand, owing t
found over the surface and through
raphy, is used for little else than
well suited. Where cultivated the
the Miami sand.

The Marshall sand is one of the
area. The ease with which it can
tures. It is not considered a strong
yields of potatoes. The texture of
of the Miami sand, and like the M
maintained by the sowing of such cr
tion of stable manure.

The Miami loam is one of the b
farming purposes, and some of the
on it. Apple trees grown on this
any other type in the county. Smal
raspberries also do well.

The Marshall gravelly loam is usu
is a productive soil, and one well ac
is the type of soil on which the gre
produced in the county are plante
adapted to the growing of a fine qua

The Miami stony loam, like the
for pasturage, because of the bowlde

were possible to remove the bowlders from the surface some parts of this type would make valuable farming land.

The Portage silt loam is the heaviest soil type occurring in the area. It is especially adapted to the growing of grass crops and for this reason is an important dairy soil. The more rolling areas of the type are well adapted to general farming, and good yields of corn, potatoes, and oats are reported. Small fruits, such as strawberries and raspberries, grow well. Apples do fairly well.

Hay, corn, potatoes, and oats are the principal crops grown on the Portage sandy loam. Of these the hay crop is the most important. Careful attention should be given to drainage and thorough cultivation on this type.

Owing to the amount of stone found on the surface and to the wet or swampy depressions occurring over it, the Portage stony sandy loam is best used for pasturage.

The Wabash loam is mellow and easily worked, and is well adapted to gardening or light farming. It is best adapted to the growing of onions. Hay, potatoes, corn, and cabbage also grow well on the type.

The Muck is at present used for little else than for the hay taken from it during the driest part of the summer. When drained it will be a valuable soil for onions, celery, cabbage, peppermint, and many other crops.

The transportation facilities of the area are very good. Four important railway lines pass through the county and give quick communication with all the large city markets. In only a few parts of the county is the distance to a railroad station over 10 miles.

Some of the wagon roads in the area are very sandy, but taken as a whole the roads are fairly good. The only roads built of crushed rock are those leading out a short distance from Stevens Point. There is abundant material to be had very cheaply for the building of gravel roads. Through the muck areas the roads are generally quite poor.

The most important market for this section is Chicago. Stevens Point, a city of about 9,000 inhabitants, is the chief local market of the area. At several different points along the railroads are stations from all of which a great deal of farm produce is shipped. At nearly every one of these are to be seen warehouses for the storing of produce, principally potatoes.

The county is well supplied with schools. The small country schoolhouses are substantially built of wood or stone. Each of the smaller places throughout the area is supplied with good schools. At Stevens Point are located a State normal school and a high school.

SOIL SURVEY OF CRAWFORD COUNTY, MISSOURI.

By W. EDWARD HEARN and CHARLES J. MANN.

LOCATION AND BOUNDARIES OF THE AREA.

Crawford County lies in the southeastern part of Missouri, about 80 miles from the city of St. Louis. It is bounded on the east by Washington County, on the southeast by Iron County, on the south by Dent County, on the west by Phelps and Gasconade counties, and on the north by Gasconade and Franklin counties. The dimensions are approximately 24 miles from east to west and 35 miles from north to south, but the southern boundary is irregular. The land surface comprises about 747 square miles, or 478,080 acres. Steelville, Cuba, Bourbon, and Leasburg are small towns in the county, supported only by agriculture. Steelville, located in the center of the county, is the county seat. Many other smaller stations and post-offices are scattered over the county.

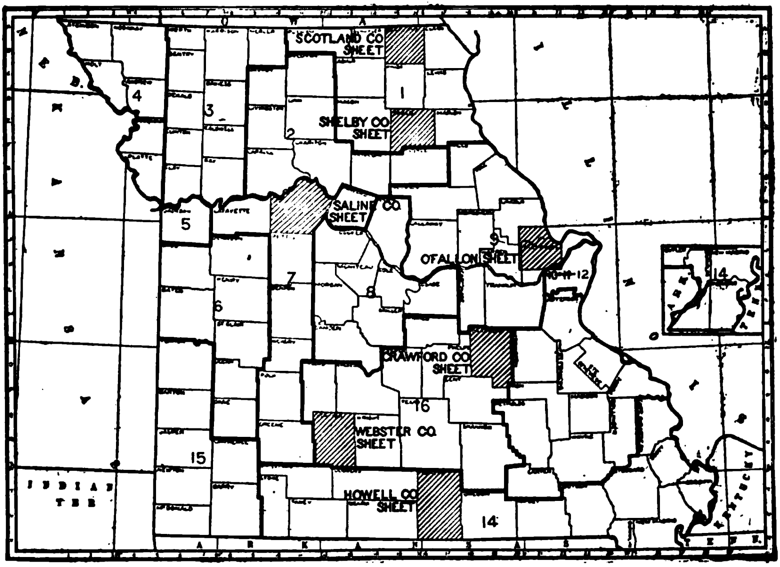

FIG. 36.—Sketch map showing location of the Crawford County area, Missouri.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The present boundaries of Crawford County were established in 1829, about eight years after the first permanent settlement had taken place. The early settlers, who came mostly from Tennessee, Kentucky, and Virginia, selected bottom lands along the Meramec River or the larger tributaries of that stream. They grew chiefly corn, wheat, and oats, and used the open forest and prairie lands as pasture.

Between the early settlement and the construction of the railroads was a period of slow but steady growth. Mills began to be built in the early thirties. The town of Steelville was founded in 1835. About 1850 settlement extended along the St. Louis and Springfield road, and Cuba, situated on this highway and now the second town in importance in the county, was laid out in 1857.

The Missouri Pacific Railway was extended through the county in 1861, and a branch from Cuba to Salem in 1871. These roads gave great impetus to local industries, especially the mining of lead and iron and lumbering. The latter had a decided influence on stock raising, as wide areas of the open oak forests were cut over and the pasture ruined by the springing up of a dense second growth of oak. The timber was cut mainly for railroad ties.

CLIMATE.

By reason of its elevation, good drainage, and excellent water, Crawford County possesses a very healthful climate.

The data given in the appended table, showing the normal monthly and annual temperature and precipitation, are taken from the records of the Weather Bureau stations at Rolla and Ironton. Rolla is distant 24 miles west from Steelville, and Ironton lies 50 miles southeast of Steelville. The average of the records of these two stations probably represents with fair accuracy the climatic conditions in the county. The rainfall is ample and is fairly well distributed throughout the year, although occasional periods of drought occur during the months of July and August.

Normal monthly and annual temperature and precipitation.

Month.	Ironton.		Rolla.	Month.	Ironton.		Rolla.
	Temperature.	Precipitation.	Precipitation.		Temperature.	Precipitation.	Precipitation.
	° F.	*In.*	*In.*		*° F.*	*In.*	*In.*
January	31.7	2.80	2.26	August	75.9	3.25	3.49
February	33.2	3.49	2.70	September	66.6	3.01	3.35
March	43.9	4.02	3.80	October	56.1	2.77	2.40
April	55.9	4.11	4.77	November	43.0	4.09	2.44
May	62.0	5.13	5.08	December	34.0	3.17	2.55
June	71.9	5.11	4.28	Year	54.2	45.33	41.63
July	75.7	4.38	4.51				

The dates of the last killing frost in the spring and the first in the fall show a growing season for the tenderest plants of about one hundred and fifty-five days. In a region with so great a difference in

topography there will be local
in the temperature. The diffe
occur between the valleys and
be considered in the growing
times a warm spell in April for
or damaged by later frost, but
the growing of tree fruits, b
weather is usually mild enoug
the last of April to the first of

PHYSIOGRA

Crawford County lies in th
Ozark Uplift. Its surface has
tral, eastern, and southern pa
while the northwest part is c
there are two distinct physiog
Frisco System is located on th
forms the drainage divide bet
nade River and those emptyin

The country to the north of t
of the county, consists of bro
hilly and rough areas near som
ning is 1,057 feet, at Cuba 1,
Prairie about 970, and at Oak
division of the county is effe
creeks and the Little Bourbeus
areas along the streams give r
rolling and rolling areas to the
loam, and the roughest areas t

The second division, includ
the railroad, has a very divers
shaped hills seen here and th
surrounding country. Severa
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areas in some places constitute
ridges are so narrow that onl
gently rolling land is found.
found between Steelville and C
paratively level or have a gra
of the stream. The roughest
the streams. Along many of
some places perpendicular wal

The limestone formation is
grained, light to dark gray n
chert found in the county is d

of this limestone. Although the chert occurs over much of the county, it is more plentiful in the southern and eastern parts. A few areas of thick-bedded, soft, white noncrystalline rock and of slightly crystalline gray limestone were encountered.

The sandstones occur sometimes in massive and sometimes in laminated structures. They vary from a soft crumbling rock to almost quartzite, and in color from white to brown, or even red. Generally they are fine grained and compact, and would make a fair grade of building stone. A few layers of Crystal City sandstone similar to the beds at Pacific were seen.

SOILS.

The soils of Crawford County have been classified into four distinct types. These are so closely related that they merge almost imperceptibly into one another, and in many cases the boundaries had to be arbitrarily drawn. Spots of stony loam, too small to be represented upon the soil map, occasionally occur in the silt loam areas, and vice versa. Small spots of rock outcrop can also be seen here and there.

The following table shows the actual and relative extent of each of the types of soil:

Areas of different soils.

Soil.	Acres.	Per cent.
Clarksville stony loam	324,608	67.9
Clarksville silt loam	109,760	23.0
Wabash silt loam	42,112	8.8
Gasconade silt loam	1,600	.3
Total	478,080	....

CLARKSVILLE STONY LOAM.

The soil of the Clarksville stony loam consists of a pale yellow to gray stony silty loam, with a depth of 8 to 15 inches. Gravel or fine angular fragments of chert occur in nearly all areas of this soil, varying in quantity from 5 to 30 per cent, while the proportion of large stones ranges from 10 to 60 per cent. Sometimes where there is a large quantity of small fragments there will be a small percentage of large stones, and vice versa. Occasionally in small spots the surface is completely covered with cherty fragments and is practically devoid of soil. In a few places sandstone rock caps the limestone on the hills, thus giving a shallow sandy loam soil, practically useless for agriculture. Such areas are too small to be represented upon the soil map. Spots of black silty loam are frequently seen at or near the foot of the hillsides, where there has been a considerable quantity of organic matter deposited and where a thick forest growth still exists. The

less stony areas on the gentle slopes
proportion of the fine material is silt.

The subsoil is a heavy red clay, te
charged with iron. Bordering the
places the subsoil is a brown or ch
rule, in typical areas there are only
subsoil, but in some places the subso
fragments of chert and grades into t
crops in many places on the stream b

The Clarksville stony loam is the
covers a little more than two-thir
unbroken areas lie in the southern
In the northwestern part it occurs i
scattered throughout the Clarksville

The topography of the Clarksville
It possesses the widest range in elev
The highest point is near Dillard,
county, and it gradually slopes to t
The type occupies the hillsides, ridge
hillsides are quite precipitous, rising
fourth of a mile. The streams hav
the areas are badly dissected. A fe
the county, while some sink holes h
presence of large caverns beneath the

The Clarksville stony loam, by rea
raphy, has excellent natural surfac
down the hillsides so rapidly that
place. The soil is warm and early,
the subsoil retains considerable w
tend to prevent washing, but also h
serve moisture.

The Clarksville stony loam is a r
the limestone formations. However
very limited extent by the weath
which occasionally caps the limesto
limestone have been thoroughly wea
parts are left as cherty fragments.
crystals also occur in the soil.

Only a very small proportion of t
vated. In some localities the type
timber, chiefly oak. In places a g
found, while in some other areas onl
be secured. The largest wooded are
last fifteen years, and on these there
oak brush. The clearing of such are

but to enable the native grasses to grow again and fit them for use as pasture, is a difficult matter. In some cases it can be done cheaply by cutting and burning the sprouts, but in others this is not feasible. Goats have been used and are said to do the work well, and at the same time to give a profit from the sale of their increase.

The Clarksville stony loam is admirably adapted to grazing purposes when the land is cleared of brush so as to allow the native bluegrass and white clover to grow in profusion. It is also adapted to apples, pears, plums, grapes, and peaches. Tobacco can be grown in a limited way on the more gently rolling and less stony areas. Although not suited to general farming purposes, the soil when manured produces fairly good crops of corn, wheat, clover, potatoes, and berries.

Land of this type sells at from $3 to $10 an acre, depending on location and distance from the railroad. Much of it is held by nonresidents and corporations on account of its prospective mineral value.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Clarksville stony loam:

Mechanical analyses of Clarksville stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13450, 13454	Soil	1.2	4.2	6.9	9.1	4.4	53.7	19.1
13451, 13455	Subsoil	.2	1.1	2.1	2.4	1.5	21.9	69.9

In a wire-basket test, using a sample of virgin soil, this type produced a remarkably large growth of plants, and the results indicate that it is not in need of any kind of fertilization. A very small increase in growth was obtained by the use of cowpeas and lime, also with nitrate of soda. Acid phosphate, sulphate of potash and lime, used separately or in combination, failed to increase the growth of plants. In this test only the fine earth was used. In the fields stone and gravel constitute about half of the soil. The soil is also shallow, and continuous cropping would probably cause it to decline rapidly in crop-producing power and to make fertilizers necessary at an early period.

In these tests wheat plants were used as an indicator, and the results obtained are not held to be applicable to unrelated crops or to soils which have had their productiveness reduced by cropping.

CLARKSVILLE SILT LOAM.

The Clarksville silt loam, known locally as "clay ridge" land, is the second most extensive type in the county, covering 109,760 acres, or 23 per cent of the area surveyed. The surface soil, which has an average depth of 7 inches, consists typically of a gray, ash-colored, or pale

yellow silt loam, with a variation
The subsoil, for a few inches or so
a heavy silt loam, usually gradin
times this clay is found immediat
light friable loam, lying on the un
of soil and broken rock. Anothe
some areas along the Meramec, wh
ally a blue clay, tough and tenacio
when wet, occurs at a depth of 30

The largest areas of the Clarksvi
western part of the county. The
Francisco Railroad forms the ge
where this type preponderates an
loam forms almost the only type.
silt loam are located in the south-
Steelville and Cherryville and to th
smaller areas are scattered over th

The general surface of this type
in the southern part of the county i
tops of the largest interstream are
quite rolling, but several gently un
observed. Generally the type occ
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Owing to the rolling surface, th
most areas does not allow the free
in some cases it is more friable and
ditches and tile drains would prov
in many places. An idea of the g
may be gained from the fact that
places by simply digging a hole to
the subsoil. Such places fill with
practically the only source of wat

The Clarksville silt loam is a re
from the weathering of limestone.
the weathering of the fine-grained
lies the greater part of this type.
sionally occur on the surface. T
the forces of weathering, has ent
loam, while the sandstone, being
oughly weathered. In the northe
Meramec River, the subsoil, as be
here a few limestone fragments w

The Clarksville silt loam is cultivated extensively, but there still remain large areas covered with brush and some smaller, more heavily timbered areas. Corn is one of the principal crops, and yields from 10 to 40 bushels per acre. Wheat yields from 5 to 15 bushels. Timothy does fairly well, while clover gives good returns upon a part of the type. Apples are one of the money products from this soil, and many orchards were observed. Peaches, pears, plums, and grapes are grown to a limited extent. Alfalfa has been tried, and does fairly well. Tobacco is grown only for home use. Berries, sweet and Irish potatoes, and vegetables do fairly well. The Clarksville silt loam in its natural state is a comparatively unproductive soil, but it is capable of being brought to a high state of productiveness if properly managed. In many places the soil is acid, more especially in some of the flat forested areas, where drainage is imperfect. This acidity can be corrected by applying lime. The soil is decidedly deficient in organic matter. This should be supplied by turning under clover or cowpeas and by using barnyard manure. By liming the soil and inoculating it, clover ought to give good yields. Apple orcharding is suited to this soil where the bed rock is more than 3 feet beneath the surface. Tobacco, cantaloupes, and berry crops should be more extensively grown, as they would likely prove profitable crops.

The improved land of this type around Cuba sells at from $20 to $30 an acre, while some of the unimproved, several miles distant from the railroad, can be bought at from $5 to $10 an acre.

The average results of mechanical analyses of typical samples of the Clarksville silt loam are shown in the following table:

Mechanical analyses of Clarksville silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13444, 13448.......	Soil.........	0.7	2.0	2.4	8.6	10.7	51.1	24.5
13445, 13449.......	Subsoil.....	.1	1.5	2.9	5.8	1.5	44.5	43.5

In order to ascertain the manurial requirements of this soil a large sample was collected and tested by the wire-basket method. The field from which the sample was taken has been in cultivation over twenty-five years, no manure or commercial fertilizer being used. The field is now in orchard, being cropped between the trees, but has been uncultivated half the time for the past eighteen years. The average yields are low, that for corn being 20 bushels, wheat less than 10 bushels, oats less than 20, and potatoes 50 to 100 bushels.

The results of the wire-basket tests indicate that a good increase in productiveness may be obtained by the use of cowpeas and lime, or by acid phosphate alone, or in combination with sulphate of potash,

or nitrate of soda; and that a very
the use of sodium nitrate, sulpha
fertilizer.

In these tests wheat plants wer
the results are held to be strictly a
to the particular field from which
seem that they might prove of mo
of this soil is under like conditions

WABASH SI

The Wabash silt loam, to a depth
to a dark or reddish-brown silty
"bottom land" or "valley land,"
narrow strips along the small strea
is free from stones, but there are a
in some localities. Spots of sandy
rence. The subsoil is a heavy bro
a silty clay or a clay loam at 24 inc
a drab clay loam, tenacious and so
20 inches a gravelly loam is foun
insufficient size to be represented
places along the streams.

The Wabash silt loam is fairly w
all parts of the county. It occu
from one-sixteenth to one-half mil
ment is along the Meramec River,
Courtois, Dry, Crooked, and Brus
only a few feet above the normal
subject to occasional overflow, b
high water.

The drainage of the greater part
where the gravelly loam subsoil is
devoted to natural meadows and p
before grain crops can be grown up

The Wabash silt loam in the mai
fine sediments which have been b
and silt loam areas and deposited
modified in many places by colluvi
spots and other irregularities of th
thin coating of sediment, and this
places.

The Wabash silt loam is natu
Crawford County, and was so recog
Generally the surface is regular an
machinery being practicable. Mo

stant cultivation for many years, and good yields are still obtained. Corn averages from 25 to 50 bushels per acre, wheat 10 to 25 bushels, timothy 1 to 2 tons, and clover does exceedingly well. Alfalfa, judging from the few fields seen, would be a profitable crop if introduced more generally. Potatoes, berries, garden vegetables, and melons do well. A part of the type is in natural meadow or forested with sycamore, oak, walnut, and other hardwoods. The soil seems best adapted to corn and grass crops, although it is a good general-purpose soil. The more sandy spots are well suited to berries, cantaloupes, and melons. Some good fruit can be grown on areas situated on the gravelly phase at the heads of the valleys or in coves. The improved land of this type sells at about $40 an acre.

The following table gives the results of mechanical analyses of typical samples of this type of soil:

Mechanical analyses of Wabash silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13438............	Soil.........	0.4	2.5	3.4	6.6	3.2	62.3	21.6
13439............	Subsoil.....	1.2	2.9	3.1	6.2	4.8	53.5	27.9

In order to ascertain the manurial requirements of this soil a large sample was collected from a field that had been in cultivation many years and received no manure or commercial fertilizer. No data concerning the crops grown on this particular field is available. The results of the tests indicate that a moderate increase in productiveness may be obtained by the use of cowpeas and lime or stable manure, but that commercial fertilizers in any form will not prove beneficial.

In these tests wheat plants were used as an indicator and the results obtained are not held to be applicable to unrelated crops or to fields which have received treatment different from that from which the sample was taken.

GASCONADE SILT LOAM.

The Gasconade silt loam, to a depth of from 8 to 12 inches, is a dark-gray to black silt loam. The subsoil, to a depth of 36 inches, is a mottled heavy silt loam, grading imperceptibly into a gray and red mottled silty clay, which in some places extends to a depth of several feet and in others rests upon unweathered limestone at a depth of 4 to 6 feet. The silty clay is frequently quite plastic and tenacious, showing a rather large percentage of clay.

The Gasconade silt loam is confined exclusively to the northwest corner of the county, where it occurs in three areas. The largest body lies just north of the town of Jake Prairie. It occupies the gently rolling and rolling uplands, with an elevation of about 950 feet. Its rolling surface insures good surface drainage for the greater part of the type, but in a few places open ditches or tile drains would prove of considerable benefit.

The soil is residual in origin, being derived from the weathering of limestone rock, probably the Jefferson City limestone. A few limestone fragments are sometimes seen on the surface, while the bed rock is only a few feet beneath the surface in several places.

The Gasconade silt loam is a productive upland soil. Nearly all of the type is under cultivation. Corn averages from 20 to 45 bushels per acre. Wheat, timothy, and clover do well. Apples, peaches, plums, and berries give fair returns. Alfalfa, although an untried crop on this type, would, it is thought, prove profitable.

Land of this type of soil is worth in open market from $20 to $35 an acre, depending upon improvements.

Below are given the results of mechanical analyses of typical samples of this soil:

Mechanical analyses of Gasconade silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13456	Soil	0.3	1.8	1.3	2.5	3.1	67.1	23.5
13457	Subsoil	.3	1.6	1.5	3.0	1.2	57.5	34.9

AGRICULTURAL METHODS.

The soils are seldom plowed to a greater depth than 5 inches, while, considering their texture and tendency to wash, they should be broken to at least 8 inches and preferably 10 inches. The depth should, however, be increased gradually from year to year, so that only a little of the subsoil will be brought to the surface at any one time. In connection with this deeper plowing there is need for a more careful pulverizing of the soil before the seed is sown and often more frequent cultivation during the progress of growth.

In the transition from the open-range system of cattle raising to the less extensive agriculture developing in the county it is but natural to find practices more or less inadequate, in certain particulars, to the new order of things. For instance, too little attention is paid to the accumulation, protection, and proper use of barnyard manure. Much live stock is kept, the soils produce the grasses luxuriantly, and there is every opportunity to increase the productivity of the soils through the natural method of applying to them unleached composted animal waste.

The matter of the rotation of crops has also been given but little attention by the farmers of Crawford County as a whole. At present the prevailing practice on the upland soils—Clarksville stony loam and Clarksville silt loam—is to sow clover in the wheat and to plow the clover sod the second year and again sow wheat, the clover reseeding itself. It is said to be unprofitable to keep the fields in clover longer than one year. Very little corn is grown in the upland, because of drought, so that under the present practices this crop would not generally do as one in a more extended rotation, although with the deeper plowing of the soil and the incorporation of coarse manures the moisture conditions may be so improved as to permit a much more general use of corn upon the uplands than at present. Cowpeas and alfalfa do well, however, and the former could be included in the rotation where a short rotation is desired and alfalfa in a more extended scheme. By sowing timothy with clover the fields can be kept in grass for three years instead of one, as where clover is sown alone. Owing to the prevalence of rust, the farmers have practically abandoned the production of oats. This crop may be grown, however, whenever the season will permit sowing as early as March. With these local conditions in view a complete rotation, as practicable as any that now suggests itself, would be: Corn, cowpeas, wheat, oats, clover and timothy. Manure should be applied to the clover and timothy sod before plowing.

The production of apples is the most prominent agricultural specialty in the county, and a large area of land has been given to the orchards. A good many have failed in their efforts to establish orchards on a paying commercial basis. In so far as these failures have been the result of improper orchard management or mistakes in the selection of varieties, the question is outside of the domain of the soil survey, but in a number of instances noted the main trouble was the selection of orchard sites where soil conditions were not favorable to tree growth. Surface conditions can not be trusted to determine the suitability of given areas to deep rooted growths like the apple tree. In all cases where there is any doubt as to subsurface conditions borings should be made and no plantings attempted where bed rock is found within 3 feet of the surface. The selection of sites for orchards should also be governed by the question of air drainage, and positions likely to be subjected to erratic frosts avoided as far as practicable.

AGRICULTURAL CONDITIONS.

The farmers in Crawford County have been generally prosperous for the last few years. The drought of 1901 left many of them in debt, but they readily recovered from this temporary setback and are now gradually improving in a material way. The best farm dwellings, which consist of neatly painted frame buildings, are seen on the

Clarksville silt loam, in the vicinity of Cuba, Jake Prairie, and Oak Hill, and on the Wabash silt loam along the Meramec River and Huzzah and Courtois creeks. The buildings on the Clarksville stony loam are usually log houses, and the general surroundings would indicate less prosperous conditions, yet it frequently happens that here the farmers have considerable means and are making a comfortable living easily. While a few good barns are seen in the county, the most of them are small and inadequate for storing the crops, housing the stock, and protecting the machinery. As a rule considerable improved farm machinery was seen on every good farm, and even the small farmers have binders, mowers, and improved plows.

About 70 per cent of the farms in Crawford County are operated by the owners. A few farms are let for a cash rental, a few are operated by managers, and others are rented for a share, usually one-third of the crops. The cheapness of land enables those of even limited means to own their farms. According to the census of 1900 the average size farm in the county contains 139 acres. Of the total land surface only about one-half of it is included in farms, while of this amount possibly not more than 100,000 acres are improved lands. Large tracts of undeveloped land are held by individuals and corporations for an advance in price or for their prospective mineral values.

The farm laborers are practically all American-born whites. Labor is quite scarce, although fair wages are paid. The wood and cross-tie industries and mining interests call into service most of the transient workers, paying them higher wages than the farmers can afford to pay.

Corn is and has been one of the main crops in Crawford County, being grown to a more or less extent on each type of soil. Wheat is also quite widely grown. Clover ranks first as a hay crop, while a considerable quantity of timothy is produced. Oats, potatoes, and vegetables, together with some sorghum, millet, tobacco, buckwheat, and broom corn, are all grown for home consumption. Of the fruits, apples are most important, and many orchards of healthy trees are found. The early apples, of which only a few are grown, are the Red June, Red Astrachan, and Early Harvest. The next to ripen is the Maiden Blush. The Jonathan, quite widely distributed, is an early fall apple. Of the winter varieties, the Ben Davis is the leading commercial variety, while the Winesap, Missouri Pippin, Huntsmans Favorite, and Grimes Golden are grown in considerable quantities. A few peaches, pears, plums, grapes, and berries are grown.

Beef cattle, hogs, sheep, and poultry are among the important products of the county. The cattle run at large over the greater part of the county and are raised ordinarily at little expense. Several carloads of hogs are shipped annually. A considerable quantity of wool is shorn, and many lambs are sold. Poultry in carload lots and a large quantity of eggs are exported. Dairy products are less important, and this industry can be greatly extended. Other sources of income to the farmers are cord wood, cross-ties, and mine props.

To emphasize a few of the salient features of the soils found in this survey a brief review is given here. The Clarksville stony loam is undoubtedly suited to grazing purposes on a large scale when cleared of the growth of brush now covering so large a part of it. It is also adapted to apples, pears, plums, grapes, and peaches. Only a small percentage of it is suited to general farming.

The Clarksville silt loam, while not a productive soil in its present state, can be made productive by green manuring, liming, etc. It is well adapted to apples where bed rock is more than 3 feet below the surface. Only fair yields of corn, wheat, and clover are secured. Alfalfa, tobacco, cantaloupes, grapes, and berries can in all probability be grown profitably on a commercial scale.

The Wabash silt loam is the best corn, clover, and timothy soil in the county. Good wheat is also grown. Alfalfa will do well. The sandy spots of this type are suited to melons and vegetables.

The Gasconade silt loam is a good all-round upland farming soil adapted to the crops of the county, including alfalfa.

Crawford County is well situated as regards transportation facilities. The main line of the St. Louis and San Francisco Railroad crosses the northwest portion of the county, while the Salem Branch of the same system runs south from Cuba through the county. In the southern part of the county there are three short railroad lines which are used chiefly for the transportation of iron ore, wood, etc. These are the Cherry Valley Railroad, Sligo Branch Railroad, and Sligo and Eastern Railroad. The dirt roads are, as a rule, in a bad condition. They could be macadamized economically, as the cherty limestone, an excellent material, is near at hand. Better roads would do much toward the advancement of agriculture in the county. More bridges should be constructed across the Meramec River, as often after a rain it can not be forded.

The market for practically all the products of Crawford County, as well as this section of the State, is St. Louis, which is less than 100 miles distant. The apples are usually sold to buyers who come into the county and superintend packing. They are shipped to cold storage plants in St. Louis. The cattle, hogs, and most of the poultry also go to this city.

SOIL SURVEY OF SCOTLAND COUNTY, MISSOURI.

By **W. EDWARD HEARN** and **CHARLES J. MANN.**

LOCATION AND BOUNDARIES OF THE AREA.

Scotland County lies in the northeast corner of the State of Missouri. It is bounded on the east by Clark County, on the south by Knox County, on the west by Schuyler and Adair counties, and on the north by the Iowa State line. It is situated between parallels 40° 18′ and 40° 36′ north latitude, and meridians 91° 56′ and 92° 21′ west longitude. It thus has about the same latitude as New York City, Pittsburg, and Salt Lake City. In shape the county is almost square, being 21½ miles from east to west and 20½ miles from north to south. It contains 439.7 square miles, or 281,408 acres. Memphis, with a population of about 3,000, is the county seat and largest town in the area.

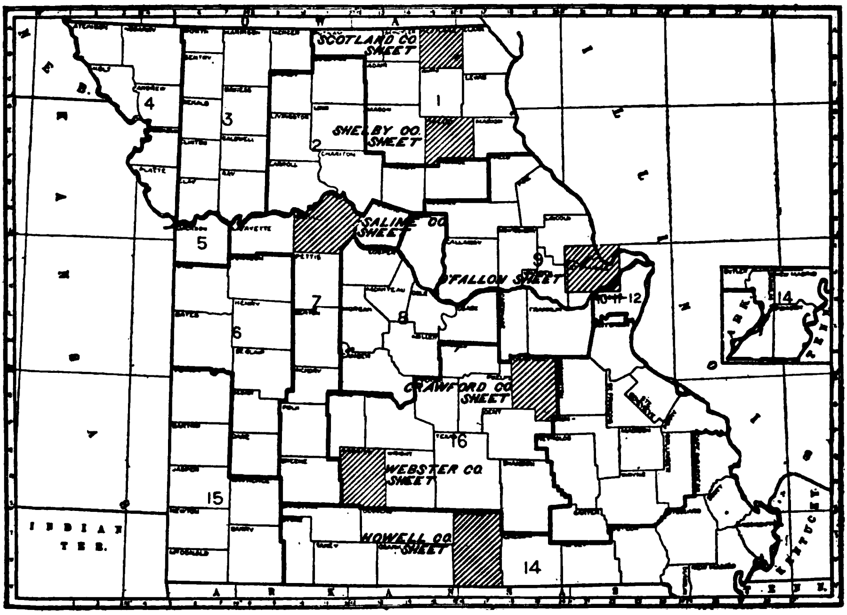

FIG. 37.—Sketch map showing location of the Scotland County area, Missouri.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Though a part of the territory acquired by the Louisiana Purchase of 1803, Scotland County did not receive a settler until 1832. At that time the present territory of Scotland County and the north 6 miles of

Knox County were included in Lewis County. In 1841 Scotland County was organized, but it contained the whole of what is now Knox County. In 1843 the present boundaries were established and Memphis chosen as the county seat.

The lands of the county were divided into three classes and placed on the market in May, 1840. The first class consisted of good land and was sold direct to the settlers by the Government. The other two classes were donated to the State, and consisted of section 16 of each township, the proceeds of which were to be used for educational purposes, and the swamp lands, the proceeds from which were to be spent in reclaiming the swamps. The land classed as swamp amounted to 31,000 acres.

The pioneers who came in 1832 and the next few years were from Kentucky, Pennsylvania, and Virginia. They settled as "squatters" on the rolling land in the vicinity of Sandhill, Biblegrove, and Pleasant Retreat, in the southern and southwestern parts of the county. Here they found a prairie country, with open woods of oak and hickory along the streams, and were thus provided with timber for building log houses and making rail fences. Hunting was excellent, deer and wild turkeys being plentiful. Hunting bands of Indians made it a practice to burn over the prairies in the fall to destroy hiding places of game. This resulted in killing all young tree growth and prevented the foresting of the prairies. Since the practice ceased a scrubby growth of oak and hickory has become very general.

With the implements then obtainable the settlers were unable to break the prairie sod, but used it as a range for cattle, hogs, and sheep. The tall prairie grass was cut and used for roughage during the winter. The first settlers could not wait for crops until they had cleared the heavily timbered lands next to the streams, so they chose the gently rolling underbrush land lying between the prairie and the timber. On this land they could raise a crop of corn the first year. The corn was ground by hand, and, with the vegetables from the garden and the game and honey from the woods, constituted the fare of the pioneers. Clothing was made of wool and skins.

As soon as efficient implements could be obtained the prairies were broken and oats became the staple crop. The yields were not so large as those obtained at present by the use of improved methods and modern implements. From 20 to 30 bushels of corn and about 20 bushels of oats per acre were considered good yields. In recent years rust has injured the oat crop and the acreage has decreased. In the early seventies considerable wheat was grown.

When railroads were constructed through the county stock raising received an impetus, and Scotland County has since become one of the greatest stock-producing counties of the State. The raising of heavy export cattle, horses, mules, and hogs is the most profitable industry, and poultry raising brings the farmers good returns. Dairying is as yet undeveloped.

CLIMATE.

No weather records are available for any place in Scotland County except Gorin, and here the records of temperature are lacking. The appended table, compiled from records of the Weather Bureau, gives the normal monthly and annual temperature and precipitation at Unionville, which lies 35 miles to the west, Steffenville, which is 25 miles southeast of Scotland County, and Gorin, which is in the southeastern part of the county. This data is believed fairly to represent the climatic conditions of the area surveyed. From these records it will be seen that Scotland County is favored with a fairly moderate normal temperature and an evenly distributed and abundant rainfall for this part of the United States. The heaviest precipitation usually comes during the months of May and June, at a time when it is especially beneficial to crops. The coldest months are January, February, and December, while the hottest are June, July, and August. The prevailing winds are southerly, but during the winter months northeasterly and northwesterly winds are frequent. Snow rarely falls earlier than the last of November or later than the first of April. Generally the weather is open and clear to about the middle of December, thus giving the farmers sufficient time during the pleasant fall months to gather their crops and sow their winter wheat.

From partial records of the dates of the first and last killing frosts, as observed at Unionville, Steffenville, and Gorin during the period from 1897 to 1904, the average dates are computed to be about the first of May and the middle of October. There is thus an average of about 165 days during which tender vegetation is in no danger from frosts.

Normal monthly and annual temperature and precipitation.

Month.	Unionville.		Steffenville.		Gorin.
	Temperature.	Precipitation.	Temperature.	Precipitation.	Precipitation.
	°F.	*In.*	*°F.*	*In.*	*In.*
January	26.0	1.50	30.2	2.20	1.65
February	24.1	2.41	24.5	1.99	1.52
March	37.4	2.01	40.7	3.16	2.44
April	52.5	3.46	53.4	3.37	3.57
May	65.0	5.20	65.3	5.96	4.79
June	73.6	4.68	72.0	4.45	3.45
July	78.7	3.75	77.7	4.22	4.41
August	76.4	4.76	76.7	2.92	2.82
September	67.6	4.75	67.1	3.79	3.87
October	56.5	2.01	55.4	2.13	2.03
November	38.2	1.60	42.8	1.79	1.98
December	27.6	2.80	28.2	1.89	1.56
Year	52.0	38.93	52.8	37.87	34.09

PHYSIOGRAPHY AND GEOLOGY.

The surface of Scotland County consists of broad, level to gently rolling upland areas, extended areas of broken and hilly country along the stream courses, and broad areas of bottom land. The county has a general southeast to east slope, the larger streams running diagonally across the county from northwest to southeast in almost parallel lines. The elevations range from 640 to about 940 feet above sea level, the highest elevations being found along the western boundary of the county.

The county is naturally divided into three distinct physiographic divisions. The first division consists of the high and practically level uplands known as prairie. The largest areas of this division are found along the Iowa line, in the vicinity of Azen, and to the southwest and southeast of Memphis. The most important upland prairie ridge begins at the southeast boundary of the county and passes in an almost straight line to the northwest corner of the county. The second physiographic division, locally known as "white oak ridges," lies between the level uplands and the bottom lands and consists of rolling, hilly, and broken areas. In some places the hill slopes rise quite abruptly from the stream bottoms. These ridges occur throughout the county, following the direction of the streams and extending along the draws that project out into the uplands. The country to the south of North Fabius River and along the western border of the area has a more broken and hilly surface than the other parts of the county. The third physiographic division consists of the low, level or sometimes gently rolling areas lying adjacent to the streams, having an elevation from 60 to 100 feet lower than the high uplands. These areas occupy a comparatively large proportion of the county and vary considerably in width. For the most part, the streams have carved out deep and very wide valleys, generally leaving steep slopes on each side. From the width of these valleys it is evident that the streams formerly carried much larger volumes of water than at present.

The South Wyaconda River, North Wyaconda River, and Fox Creek, which have their sources in Iowa, enter the county from the northwest and flow through the northeastern part in an almost parallel southeastern direction. The north fork of the North Fabius River enters the county near the northwest corner and empties into the North Fabius River about 1½ miles west of Memphis. From this point the North Fabius River flows in a southeast direction and leaves the county about 2½ miles west of the southeast corner. The Middle Fabius River and the north fork of the Middle Fabius flow through the southwestern part of the county. All these streams, with their numerous tributaries, form an excellent drainage system. There are a few slight depressions in the bottoms in a semiswampy condition, but these can be drained and made cultivable by straightening the stream channels and clearing them of logs and brush.

In the bottom areas the streams are relied upon to a considerable extent for water for stock. In the uplands basins are dug, and by the process of puddling a small pond is formed which catches and holds the rainwater. In some parts of the county well water is hard to obtain at any reasonable expense, while in other parts water can be obtained at a depth of from 20 to 60 feet. Cisterns are used extensively throughout the county.

The soils of Scotland County are of glacial, loessial, and alluvial origin. Bed rock, consisting of limestones, sandstones, and shales, all of the Subcarboniferous period, lies deeply buried beneath the surface and only one or two outcrops of it are to be seen in the county. Overlying the bed rock is glacial drift material of the Kansan glaciation. This has a depth varying from 65 to 150 feet or more and consists of yellow or blue clays with some sand and glacial gravel scattered through it, with here and there masses of soft lime concretions. This formation gives rise to the Shelby loam. The loess is a thin covering of wind-blown material overlying the glacial drift and gives rise to the Shelby silt loam. The alluvial material along the streams is formed by the wash from the loess and drift areas and gives rise to the Wabash silt loam and the Wabash clay. Near Memphis some brick and tile are made from this material.

SOILS.

Four distinct types of soil were mapped in Scotland County. The extent of each is shown in the following table. The soil map is also, in a way, a physiographic map of the county, since each soil has a characteristic and distinct topographic position.

Areas of different soils.

Soil.	Acres.	Per cent.
Shelby silt loam	136,704	48.5
Shelby loam	94,016	33.4
Wabash silt loam	46,016	16.5
Wabash clay	4,672	1.6
Total	281,408	

SHELBY SILT LOAM.

The soil of the Shelby silt loam consists of a light to dark gray silty loam, varying in depth from 12 to 16 inches. It contains a large quantity of organic matter and when wet is black in color. This type is locally called "prairie land." It is a mellow and easily-tilled soil.

On a few narrow ridges of this type, which are sometimes forested to oak and hickory, the soil is a yellowish-gray silt loam. In some localities a thin stratum of whitish crumbly silt lies between the soil and subsoil. The subsoil to a depth of 36 inches is a heavy clay or silty clay. The characteristic colors are gray mottled with yellow, brown, or drab, frequently streaked with yellow or brown. This material is tough and hard and is very impervious to water. It is locally known as "hardpan," but is not hardpan in the correct sense of the word. Immediately below the subsoil is often found a blue or steel-gray colored clay. Upon exposure to atmospheric agencies the subsoil changes to a dull brown color, cracks open when dry, and is very plastic when wet.

The Shelby silt loam is the predominant soil type of the county and is well distributed over the area. It occurs on the upland ridges or "prairies" lying between the streams and forms long, continuous areas extending diagonally across the county from northwest to southeast. The surface of this type is level or gently rolling. It has an elevation of from 730 to 940 feet above sea level and lies from 60 to 100 feet above the level of the bottom lands.

The greater part of the Shelby silt loam has fairly good surface drainage. There are some flat areas which need artificial drainage to secure the best yields and permit easier cultivation. Some of the farmers have resorted to a broad, high bedding of the land and have obtained good results. Tiling will prove beneficial and profitable, as the subsoil is of such a nature that it is almost impossible for water to penetrate it. The structure of the soil is such that it easily rids itself of excess water, and yet it is able by capillary action to draw up from below sufficient moisture for growing crops. Good crops can be secured on this soil in all but the driest seasons.

The Shelby silt loam is of loessial origin. It is composed chiefly of silt, with not more than 5 per cent of all grades of sand and about 20 per cent of clay. It is a very uniform soil, as is the case with all loessial formations. The subsoil, however, contains a higher percentage of clay than is commonly found in loessial deposits.

The Shelby silt loam is adapted to corn, oats, timothy, and sorghum, and to alfalfa and clover on the well-drained areas. Practically all of this type is under cultivation. It sells for from $50 to $80 an acre, and some of it near Memphis and Gorin is held at $100 an acre.

Upon this type are grown all the crops common to the county. Corn yields from 30 to 50 bushels, oats 30 to 55 bushels, and timothy 1 to 2 tons per acre. Sorghum does well, but clover does not give good returns. Potatoes, berries, and fruits, including apples, pears, and cherries, do well. Large areas are in timothy pasture, and many cattle, hogs, and a few sheep and horses are raised on the best farms.

The following table gives the
of samples of this soil:

Mechanical ana

Number.	Description.	Fine gravel.	Co sa
		Per cent.	*Per*
13590, 14031	Soil	0.1	
13591, 14032	Subsoil	.4	

In order to study the manu
sample was collected for exan
method. The sample was tak
Memphis. The soil is a dark-g
It contains a large amount of o
well. The field from which th
vation about thirty years, has
but has received no fertilizer of

The results obtained indicat
tiveness may be obtained by t
and lime, sulphate of potash a
soda will produce a fair incre
lime, or acid phosphate will pr
used alone. In these tests wh
and the results are held to be s
and to the field from which t
however, that they will be fou
type of soil throughout a large

SH

The surface soil of the Shelb
consists of a gray to light-bro
loam, the color depending upon
porated with the soil. In som
the soil is a light-gray or yello
the head of some of the draws
strips of a heavy black soil, w
type, but which could not be
loam on account of its small e
inches or more, is generally a
clay, of a stiff, tough texture,
and some glacial gravel. Here
ally on the surface, large gra
quite calcareous, many small, i

tered in most areas. The subsoil is a true bowlder clay or till, having a somewhat granular structure when dry and being very plastic and sticky when wet. Sometimes it is underlain by blue or gray clay.

The Shelby loam occurs throughout the county, but as the southwestern part is rolling the largest proportion of this type is located in that region. The type is confined to the vicinity of the stream courses and almost invariably lies between the Wabash silt loam of the bottoms and the Shelby silt loam of the uplands. No broad areas occur, the type usually forming narrow, extended strips with points projecting into the Shelby silt loam areas. The type embraces practically all of the broken and hilly land in the county. It is confined to the hillsides, knolls, and rolling ridges, and no flat areas of it were encountered. About three-fourths of it can be cultivated, while the remaining portion is suited only to pasturage or forestry. Owing to the rolling surface of this type, it has excellent natural drainage, and in many places the rainfall runs off so rapidly that serious erosion has resulted, the small streams and draws cutting deep channels through the soil. This erosion can be prevented to a great extent by ditching, by terracing, by deeper plowing, thereby enabling the surface soil to take up larger quantities of the rainfall, or by seeding these hilly areas to grass and using them for pasture.

The Shelby loam has been derived, through the processes of weathering, from the glacial material of the Kansan drift. It seems that this material, or at least a part of it, was once covered by the loess, and that the Shelby loam has resulted largely from the washing of this loess from the surface of the glacial drift, thus exposing the latter to the action of the elements. The relatively high percentage of sand in the soil in many places would indicate that a considerable amount of clay and fine silt had been carried away in suspension.

The Shelby loam is a good general farming soil, and in wet seasons is more productive than the other soils. It is adapted to tobacco—a crop not grown in this area, but grown in the adjoining county to the west—clover, fruits, berries, potatoes, sweet potatoes, and wheat. Truck crops and vegetables do well on the sandy slopes with southern exposure, where they mature early. The lime in the subsoil of this type is one of the ingredients needed for the best development of clover and alfalfa. When the soil is cleared, bluegrass grows naturally.

The Shelby loam produces from 25 to 40 bushels of corn, 25 to 45 bushels of oats, and 10 to 25 bushels of wheat per acre. Clover, timothy, potatoes, apples, cherries, and pears do well. A considerable proportion of the type is still forested to white oak, post oak, hickory, and elm, and quite a large amount is in pasture. Many cattle, hogs, and sheep are raised on these rolling areas. This type, because of its topography, is especially suited to sheep pasturage.

The following table shows the ave
of samples of this soil type:

Mechanical analyse

Number.	Description.	Fine gravel.	Coarse sand.
		Per cent.	*Per cent.*
13588, 14027	Soil	0.7	4.2
13589, 14028	Subsoil	1.3	3.4

WABASH SI

The Wabash silt loam, to a depth
to dark gray silty loam or a gray
which contain quite a large percent
dark color when wet. In many pl
centage of fine sand and occasiona
few areas of fine sand or sandy loa
are found at the base of the slopes
"gumbo" occur, but they are too sn
subsoil is a silty loam, varying in
usually compact and sometimes w
running through it. In some locali
drab colored heavy fine sandy or si

The Wabash silt loam is a botto
throughout the county. The large
and Middle Fabius rivers, South
rivers, and Fox Creek. Smaller a
along the tributary streams. This
width from one-sixteenth of a mile t

Occupying the first and sometin
streams, this type for the most pa
bottoms are uniformly flat, but tl
gently rolling with a gradual slope t
from 60 to 100 feet below the level u
is subject to overflow during the spr
during the summer. By diking in so
of logs and brush this type could b
flow. Open ditches are necessary t
be beneficial in some places. Ow
table, this soil has good moisture su

The Wabash silt loam is of alluvi
mulation of sediments washed fro
Shelby loam areas, together with th
headwaters of the streams. Owing
formed it is somewhat variable in
organic matter it contains.

This type is well suited to the production of corn, timothy, rye, and oats, and the well-drained areas to clover. Sorghum does well. A considerable proportion of this type will probably prove a very desirable soil for alfalfa, and this crop should be given a trial. The percentage of Wabash silt loam under cultivation in any one year depends upon the season. In a fairly dry season practically all of the cleared land will be cropped, but in a wet season only the second bottoms and small areas of the first bottoms will be planted. Some of the type is forested to oak, hickory, and elm, and parts of it are badly dissected by stream channels. Corn produces from 25 to 80 bushels per acre, with 40 or 45 bushels as an average yield in a good season. Timothy yields from 1 to 2½ tons per acre, and clover also does well. Rye gives large yields. Sorghum makes from 50 to 200 gallons of sirup to the acre. Cucumbers are grown with good results.

The following table gives the average results of mechanical analyses of samples of this soil type:

Mechanical analyses of Wabash silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14035, 14037	Soil	0.1	0.6	0.4	2.5	11.2	62.7	22.1
14036, 14038	Subsoil	.2	1.3	.5	2.1	7.4	57.9	30.3

WABASH CLAY.

The Wabash clay, to a depth of 8 to 10 inches, is a heavy silty loam or clay loam of a dark-gray or black color. The more silty phase has a dark-gray color, while the heavier and more typically developed areas have a black clay loam soil. The soil is sticky when wet and cracks and bakes hard when dry. It is locally called "gumbo" and is a difficult soil to till. Special care must be taken to plow this soil when it contains the proper amount of moisture, if good tilth is to be secured. The subsoil to a depth of 36 inches or more consists of a drab or mottled gray, sticky, gummy clay, possessing a large clay content and being quite impervious to water. In some places a water-bearing stratum of sand is found several feet beneath this clay.

No large areas of this type were encountered in Scotland County. The greatest development of the type is seen along the North Fabius River to the southeast of Memphis, where it occurs in a long, narrow, disconnected area. A few smaller areas were found in the Wyaconda bottoms and along a few other streams. Patches of this soil too small to be shown upon the soil map are found scattered throughout the Wabash silt loam areas.

The Wabash clay is characterized by a uniformly level and slightly depressed surface. It occurs only in the flat bottom areas near the

streams, is subject to frequent ov
occasionally flooded in the summ
slightly depressed surface the drain
few of the sloughs for the greater p
is, however, sufficiently well draine
ditches and tiling are essential to th
present crops are liable to be overf
the areas, but if the natural drain
cleared of brush and logs this land
In some places diking would pay.
in the spring that it is sometimes i
time for it to mature before frost.

The Wabash clay is of alluvial ori
which have been deposited by the "
streams. It has a high organic-mat
the wet condition of the soil has fav
of vegetable matter.

This soil is peculiarly well adapte
of these crops ought to be secured.
cultivated, and the yields depend o
dryness of the season. Some fields
was from 40 to 70 bushels per acre,
scarcely any, because the soil was t
forested. Most of it is used for pas
hay is cut. Owing to the fact tha
subject to overflow during the cro
been fully appreciated. The Waba
ductive soil in the county, and it is
it is drained and in profitable cultiv

The following table gives the aver
of samples of this soil type:

Mechanical analyse

Number.	Description.	Fine gravel.	Coarse sand.
		Per cent.	*Per cent.*
13592, 14041	Soil	0.3	1.9
13593, 14042	Subsoil	.4	1.6

AGRICULTURAL

The farmers of Scotland County a
1894 and 1895 this section suffered f
low, and the farmers were very mu
however, they have secured fairly g

more attention has been paid to the live-stock industry, and the condition of the farmers has steadily improved. Fairly good frame buildings, usually painted, are seen over the county. A few log houses still remain and are in striking contrast with a few beautiful modern houses scattered here and there through the area. The barns are ordinarily good, but not so conveniently arranged or so commodious as the barns in the Eastern States. The old rail fences are being torn down and new fences are being built, usually of barbed wire or woven wire at the bottom, with 2 or 3 strands of barbed wire above. Modern farm machinery, including sulky plows, riding cultivators, mowing machines, binders, etc., are used on nearly every farm. The prairie farms, which present the greatest evidences of prosperity, are held at from $50 to $100 an acre, the latter price being for land near Memphis or Gorin. Land for grazing purposes can be bought for from $25 to $40 an acre. The best lands in the county promise to increase considerably in value.

Between 60 and 75 per cent of the farms in the area surveyed are operated by the owners. The remaining farms are leased either on shares or for cash. The grain rent is commonly two-fifths or one-half of the crop produced, while the cash rent varies from $2.50 to $4 an acre. The size of the farms varies greatly throughout the county. They range from 40 acres to 160 acres or more, but 130 acres probably represents the average. Frequently one person owns more than one farm, thus making the average statistics somewhat misleading.

The labor employed is nearly all white. Generally there is no difficulty in securing labor except during harvest time. Wages by the month, including board and lodging, range from $18 to $25. The ordinary price of day labor is $1.25, but during harvest it commands from $1.50 to $2.50 a day.

Farming in Scotland County is based almost entirely upon stock raising. In general, the county is stocked with an exceptionally good grade of beef cattle, horses, mules, sheep, and hogs. A great many herds of well-bred Angus and Shorthorn cattle and fattening steers are kept, but the dairy breeds are absent. The Duroc Jersey seems to be the most popular breed of swine, though some Poland China hogs were noted. A few horses and mules, as well as some hay and oats, are shipped out of the area. The main money-yielding products, however, are beef cattle, hogs, and sheep. Scarcely any grain is shipped, as it is more profitable to feed it to cattle and hogs and sell them than to sell the grain. Many farmers throughout the county buy cattle and fatten them for market.

The main crops grown are corn, oats, and timothy hay, while the secondary crops are wheat, rye, clover, potatoes, sweet potatoes, cucumbers, millet, and sorghum. Oats are usually planted on land that has been in corn for two years, and are followed by wheat, rye, or

pasture. The acreage devoted to
is the most important grain crop
were seen. Some fields with an exc
evidently the result of poor seed.
to use greater care in the selectio
also show a lack of thorough culti
geous to cultivate the crop thorough
rape, vetch, or cowpeas between t
up to cockleburs and other weeds.

The farmers of Scotland County
stover. There are very few farm
it, though the Missouri experimen
equal to one-half the same weight

Pumpkins, planted in the corn,
It is estimated that 14 tons of pu
bushels of corn, so that a good yiel
value of an acre of 50-bushel corn.

Around every well-established h
occasionally a small orchard. A s
peach trees were noted. All of
peaches, which are apt to winterkil
to the production of apples, pears,
Cucumbers are grown for picklin
secured.

Many large fields of gently rollin
more profitably employed for gro
broken land along the streams is w
Pastures in which clover is kept gr
two to three times more cattle th
bluegrass. A valuable crop for th
of the bottoms is alfalfa. It is be
acreage is increasing each year.
on land from which a crop of whe
disked. The latter part of Augus
the best time for sowing alfalfa in
nurse crop does not usually give as

The plowing done in the county
should be plowed a little deeper eac
is reached. Fall plowing gives by
meadow land. Deep plowing sh
slopes, so that the soil can absorb t

So far as is known, no commerci
It is highly probable that lime appl
soils would improve their texture a

Attention has been given in only a general way to the adaptation of the different soils to certain crops. The Shelby silt loam is a good soil for corn, oats, and hay, and by the addition of lime and better drainage of some areas fairly good yields of clover, alfalfa, wheat, fruits, potatoes, and navy beans can be secured. The Shelby loam is well suited to the production of wheat, clover, fruits, beans, berries, and potatoes, and on the sandy slopes with a southern exposure to early truck crops. It is also well adapted to pasturage. Tobacco will do well on this soil. The Wabash silt loam is admirably adapted to the production of corn, oats, hay, rye, and cucumbers. The Wabash clay is a strong soil and is capable of producing large yields of corn and hay when better drained.

A branch of the Chicago, Burlington and Quincy Railway traverses the central part of the county from east to west. The main line of the Atchison, Topeka, and Santa Fe Railway crosses the southeastern corner of the county. The county roads follow in part the section lines or run parallel with them, and are fairly well distributed over the county. In the summer and fall they are in good condition, but are very bad when the ground thaws in the spring. The rural free delivery of mail is in operation throughout the greater part of the county. Good schoolhouses are seen in the rural districts, and the compulsory attendance law is enforced.

Memphis, Gorin, Rutledge, and Granger consume quite a large quantity of the fruits, vegetables, and poultry produced in the county. Chicago is the market for the cattle, hogs, and sheep, and for most of the other products shipped out of the county.

SOIL SURVEY OF SARPY COUNTY, NEBRASKA.

By **A. E. KOCHER** and **LEWIS A. HURST.**

LOCATION AND BOUNDARIES OF THE AREA.

Sarpy County lies a few miles south of a line drawn east and west through the center of the State, and is in the eastern tier of counties bordering the Missouri River. It is included between 41° and 41° 11′ 35″ north latitude and 95° 50′ and 96° 20′ west longitude. The Platte River elbows around the west and south sides of the county, while Douglas County bounds it on the north. The county is longest from east to west, with a slight dip in the southwestern corner. It has an area of 226.7 square miles or 145,088 acres, all of which was included in the present survey. The city limits of Omaha are but little more than 2½ miles north of the area surveyed.

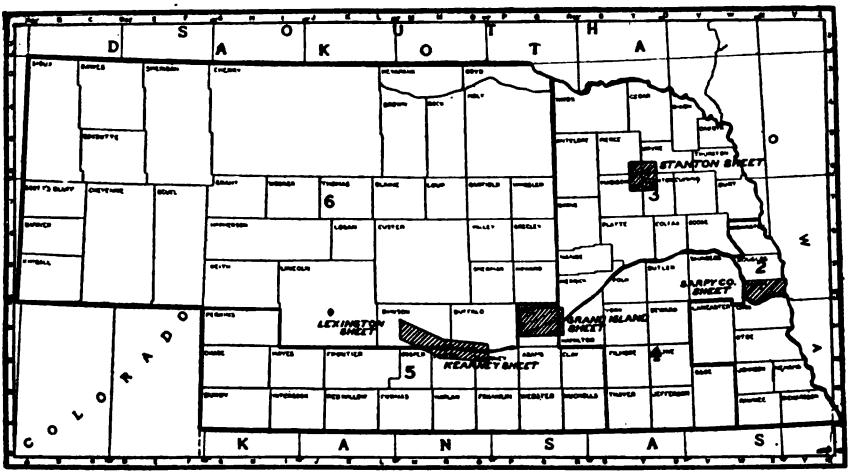

FIG. 38.—Sketch map showing location of the Sarpy County area, Nebraska.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

As early as 1810 fur traders of the American Fur Company established a post on the west bank of the Missouri River within the present limits of Sarpy County and for years carried on active trade with the Indians. In 1854 the town of Bellevue was founded and the surrounding country thrown open to settlement. Noticeable development did not take place, however, until 1857, when Sarpy County was organized under the Territorial government, with Bellevue as its county seat. Papillion, now a town of 600 inhabitants, was founded in 1869, and six years later became the county seat. Other important towns are Springfield, Gretna, Richfield, Chalco, Fort Crook, and Laplatte.

From the beginning of agriculture in the county, whether practiced by the white man or the Indian, the dominant crop grown has been corn, and by good cultivation and careful selection of seed much improvement has been made both in yield and quality. From 1857 to 1867 considerable spring wheat was grown, but toward the end of this period the yields began to decrease, so the acreage was reduced and the crop no longer occupies a prominent place in the agriculture of the county. For a time considerable winter wheat was grown, but with the fall in price following the development of new wheat-growing sections in the north the crop was largely abandoned for corn. There has been a continued increase in the acreage of alfalfa, clover, and tame grasses, and, while their value in the rotation is not yet fully appreciated, they are a promising feature of the agriculture of the county. Since the extensive development of the packing industry at South Omaha the live-stock industry has assumed considerable importance, but is yet far short of its most profitable development. In the vicinity of Omaha trucking has been extensively developed, and on the Elkhorn River lowlands the production of melons and cucumbers for seed is proving profitable.

CLIMATE.

The climate of Sarpy County is marked by sudden changes of temperature, moderate winds, a favorable rainfall, and a high percentage of clear days. The winters are usually cold and changeable, with so small an amount of snow that winter grains are sometimes badly injured for lack of adequate protection. According to the Weather Bureau records, the annual precipitation at Omaha is 31.69 inches, and at Ashland it is 29.53 inches. Over 50 per cent of this falls during the four growing months—April to July, inclusive. The normal annual temperature at these two stations is 49.6° and 50.9°, respectively. At Omaha the average date of the last killing frost in spring is April 10 and the first in fall is October 20, giving an average growing season of one hundred and ninety-three days. At Ashland the average length of the growing season is one hundred and sixty-eight days, with the last killing frost in spring occurring on April 21 and the first in fall on October 6. According to the Weather Bureau records at these two stations the hottest months in the year are July and August, and the coldest months are December, January, and February. The greatest range of recorded temperature was in 1899, when a total range of 125° was registered.

The following table gives the normal monthly and annual temperature and precipitation at Omaha and Ashland. the two Weather

Bureau stations nearest to the ar
secured:

Normal monthly and annual te

Month.	Omaha.		Ashland.	
	Temperature.	Precipitation.	Temperature.	Precipitation.
	°*F.*	*In.*	°*F.*	*In.*
January	19.2	0.69	23.8	0.59
February	25.0	.79	23.3	.61
March	35.5	1.50	37.4	1.19
April	51.0	3.13	52.8	2.67
May	61.7	4.37	63.3	4.47
June	71.5	5.67	71.9	4.62
July	76.2	4.75	77.0	5.04

PHYSIOGRAPHY

Sarpy County, the smallest count
between the Platte and Missouri ri
three sides. These streams have c
feet below the former level of the g
two distinct physiographic divisions

The topography of the highlands
tures consisting of high, level plate
cipitous bluffs. The highest altitud
to 1,300 feet above sea level and ar
county from 2 to 3 miles east of the
extending north and south, forms
Platte and the Missouri river syst
the drainage of the county is chiefly

Eastward from the tableland the
by a high, narrow ridge, which ex
county and constitutes all that re
To the north of this ridge the dr
Creek, find their way in a southe
River. Papillion Creek, the largest
within the area, is formed by the ju
creeks and is notable as being t
waters flow direct to the Missouri
tributary streams, the most impo
Creek, has its source within 1½ miles

The southern half of the county
characterized by numerous deep-cu
are Buffalo, Goose, and Weather
streams have branched and rebra
valleys back into the upland areas, t

days has been gradually worn away until now it is little more than a narrow ridge.

In the southern part of the county the highlands extend nearly to the Platte and leave only narrow strips of lowland along the river. The largest areas of lowland soils are found in the eastern part of the county along the Missouri River and in the vicinity of Laplatte. These bottoms are little more than broad, low flood plains, over much of which the rivers still flow in time of exceptionally high water. The Missouri River is notable for the ease and frequency with which it shifts its channel, having moved within the last twenty years about 3½ miles from its former course.

During times of high water the Platte is a swiftly flowing river from one-half to nearly 1 mile in width, but in the summer when the waters have gone down the shallow current divides and redivides, leaving wooded islands and low, barren sandbars in the river bed.

The Elkhorn, another important river of the State, enters the county from the north, about 4 miles from its confluence with the Platte, and by its overflows has formed a rich deposit of variously textured soils which are highly prized for their production of wild hay.

The geology of Sarpy County is comparatively simple, the entire area having been buried during the glacial period under from 100 to 300 feet of loess. Since that time this material has been entirely removed from three sides of the county by the action of the Platte and Missouri rivers, whose tributaries have carved out channels from 50 to 160 feet in depth and changed the landscape of the highlands from a moderately level plain to a surface of marked irregularity.

Along the bluffs in the western and southern parts of the county a few glacial bowlders have been exposed by the wearing away of the silty clays in which they were embedded.

Underlying the glacial deposit is a thin bed of brown Dakota sandstone of Cretaceous age. This in turn is underlain by beds of valuable white carboniferous limestone, into which the Platte has cut a channel from 50 to 100 feet deep. The upper Carboniferous is said to be the oldest formation exposed in the State and is marked in this county not only by limestone beds but by valuable deposits of fire clay as well. The limestone outcrops from the bluffs which rise from 50 to 150 feet above the Platte River bottoms. Excellent railroad facilities have been provided along the base of the bluffs, and extensive quarries are being developed. Much of the rock quarried is used at the large smelters at Omaha or as foundations for buildings in or near the city. Quantities of the rock are also shipped to Lincoln, where it forms an important ingredient in the construction of street pavements.

In the vicinity of these quarries are frequently found small areas of sharp, coarse sand brought down and deposited here by the river. This material is also highly prized in the construction of concrete, and many carloads are annually removed.

In the eastern part of the county
silt loam are being used in the m
plant is being operated with a dail
high-grade product is being manufa
are also found along the bluffs of th
being worked up at the Avery plant

SOII

Seven distinct soil types were rec
County area. Of these the Marshal
are loessial in origin and occupy th
tuting 75 per cent of the total ar
types are all alluvial in formation a
toms. They range from heavy clay
continually changing in texture as t
wash away deposits previously laid
The following table shows the tota

Areas of diff

Soil.	Acres.	Per cent.
Miami silt loam	69,696	48.1
Marshall silt loam	39,232	27.1
Wabash silt loam	18,496	12.8
Laurel fine sandy loam	5,760	4.0

MIAMI SIL

The soil of the Miami silt loam is a
deep, with an average depth of 5 in
yellow silt loam or silty clay, which
change to a depth of 100 feet or m
found, and when wet both soil an
which has given rise to the term "
locally known throughout the area.

The Miami silt loam is of general c
occupying nearly one-half of the tot
normally as long irregular-shaped st
ing the numerous deep-cut streams a
found on the higher level tracts i
cultivation.

The surface of the type is very ro
is too steep to admit of cultivation.
1,260 feet above sea level and from
level of the rivers.

The drainage of this soil is always good, and on the steeper slopes it is often excessive. The silty material, when once erosion has begun, wears away at a very rapid rate. In a few localities considerable damage has been done by the deep gullying of the hills. To correct this and prevent the future washing of the soil is a difficult and expensive task. In many fields where erosion has just begun much damage could be prevented by the construction of a few inexpensive terraces and by subsequent judicious plowing.

The Miami silt loam is composed of loessial material. Since the type has been brought under cultivation, erosion has been active and the depth of the original surface soil has steadily decreased, until now in many fields small areas occur from which the darker, organic-stained material has been completely removed. These areas, together with those on which the subsoil is exposed by plowing, give the fields the peculiar streaked appearance characteristic of the type.

For the first half-mile back from the Platte River bluffs the local color of the soil is distinctly lighter and the subsoil is frequently of a reddish-yellow hue.

The Miami silt loam is probably as well adapted to corn as to any other crop, but in many instances the type has suffered by continued cultivation to this crop. Clover, alfalfa, and grass do well and should be introduced more extensively into the system of rotation. With the introduction of these crops humus would be added to the soil, its productivity increased, and much ruinous erosion prevented. The average yield of corn is about 40 bushels to the acre. Wheat yields from 20 to 25 bushels and alfalfa from 3 to 5 tons per acre. The type is highly prized throughout the county and ranges in value from $60 to $100 an acre.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Miami silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14050, 14052	Soil	0.1	0.4	0.1	0.6	13.6	69.1	16.0
14051, 14053	Subsoil	.1	.1	.1	.7	15.5	67.8	15.6

MARSHALL SILT LOAM.

The soil of the Marshall silt loam consists of a black heavy silt loam from 8 to 13 inches deep, with an average depth of about 10 inches. The content of organic material is high and the soil when dry is loose and friable. The subsoil, identical with that of the Miami silt loam, is a brownish-yellow silt loam or silty clay extending to a depth of many feet.

Like the Miami silt loam the Marshall silt loam is found in all parts of the upland portion of the county in irregular-shaped areas which are always contiguous with bodies of the former type. The two types are very similar, the only differences being the deeper, blacker soil with a higher organic-matter content and the more level topography which the Marshall silt loam usually possesses.

As a rule the type occupies the high, level plateaus and the gentle slopes, although it is sometimes found in small areas on steep hillsides which are still forested or which have not been long in cultivation. The localities around the heads of the streams are usually covered by this type. In the upper part of the small stream courses a phase of the type is found consisting of a black silt loam from 3 to 20 feet or more in depth, which lies in long, narrow areas seldom more than 40 rods in width and nearly always divided into two parts by a narrow vertical-walled ditch, which has been eroded to a depth of from 10 to 40 feet.

The sloping surface of the Marshall silt loam affords excellent drainage. More attention should be given to the methods of cultivation in order that erosion may be checked and the removal of the rich surface soil prevented.

The Marshall silt loam is derived from loess, the immediate surface of which contains a high percentage of organic matter. On the higher areas this covering is being gradually worn away and the type converted into the Miami silt loam, while the washed material collecting on the lower slopes is constantly adding to the area of the Marshall silt loam.

This soil is well adapted to all of the crops commonly grown in the county. Corn is the chief crop, but the area devoted to alfalfa is annually increasing. Owing to the eroded condition of the narrow areas of the deep valley phase, they are usually devoted to pasture. Along the lower slopes potatoes are extensively grown and yield from 150 to 250 bushels per acre. Wheat yields from 20 to 30 bushels and oats from 35 to 45 bushels per acre. Alfalfa returns from 3 to 5 tons per acre and corn from 40 to 60 bushels, and higher yields are frequently secured. In the vicinity of Omaha extensive areas of the type are devoted to market gardening, and the industry is proving very profitable.

Along the stream courses where sufficient water can be had for irrigation the soil is well adapted to the growing of celery, and it would seem that the cultivation of this crop could be profitably introduced.

Because of its position the Marshall silt loam is considered one of the most desirable soils in the county and has a value of from $70 to $100 an acre.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Marshall silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14046, 14048	Soil	0.1	0.3	0.1	0.4	10.3	69.6	19.1
14047, 14049	Subsoil	.1	.2	.1	.3	9.7	72.5	16.9

LAUREL FINE SANDY LOAM.

The Laurel fine sandy loam, owing to its origin as river sediment, has a wide variation of structure and texture. The larger proportion of this type consists of a yellowish-brown or gray fine sand or fine sandy loam 16 to 24 inches in depth, with an average depth of 20 inches, underlain by a gray or light-brown silty loam containing much very fine sand. The silt content increases with depth, and at from 30 to 36 inches the subsoil may contain some clay. A phase of this type, found chiefly in the vicinity of the Platte and Elkhorn rivers, consists of a thin layer of yellowish-brown clay or silt loam underlain by yellow or brown fine sand.

In all eleven bodies of this type were mapped, varying in extent from a few acres to 2 or more square miles. One of these bodies lies north of Bellevue and another just east of Laplatte. These and two smaller bodies include all of this type mapped in the Missouri River Valley. The remaining bodies are found along the course of the Platte River, chiefly in the western part of the area. The type is found exclusively in the valleys, and usually occupies flat benches along the present stream courses or where these streams formerly had their channels. The type has an elevation of from 2 to 12 feet above the normal level of the streams, and descends abruptly to the stream courses when found in proximity to them. Where the elevation is 5 feet or more above the stream level, adequate drainage is afforded for most of the crops grown. Like the other soils of the valleys, this type is generally subject to overflow. The floods usually come during the growing season and frequently destroy the entire crop.

This type is alluvial in origin, having been formed by the deposition of materials carried in suspension by the rivers. This sediment was derived from the weathering of sandstone and other materials farther up the stream courses and was brought down chiefly during times of floods.

The chief crops grown upon this type are corn and potatoes. Occasionally, when the seasons are favorable, wheat and oats are included in the system of crop rotation. When properly drained the soil is well adapted to the growing of muskmelons, watermelons, cucumbers,

and cabbage. Small fruits also
yields of the principal crops are: (
wheat, 20 bushels, and potatoes, 10

The value of the Laurel fine sand
for cultivation. Some of it is held
it is worth less than $50. The v
the last few years owing to a success

The following table gives the ave
of samples of this type:

Mechanical analyses of

Number.	Description.	Fine gravel.	Coarse sand.
		Per cent.	*Per cent.*
13628, 14056......	Soil.........	Tr.	0.2
13629, 14057......	Subsoil.....	.0	.1

The following samples contained more than one-l
14056, 4.5 per cent; No. 14057, 4.6 per cent.

LAUREL FI

The soil of the Laurel fine sand i
grayish-yellow color, with an averag
the material is very similar to the
the structure is considerably more c

The Laurel fine sand is confined t
long, narrow ridges adjacent to the
farther inland. In St. Mary's ben
areas are found, the river has shif
within the last twenty years. In t
plains adjoining, where the curren
swift, the bodies of Laurel fine san
found as low, barren islands in the
Missouri rivers. These areas are c
the current adds fresh material or c
deposited. Thus within a year th
present size, or, on the other hand
wind is also active in the formation
tities of the dry material across the
or ridges along the river bank. Th
height and in places are rapidly
farther inland.

A phase of the Laurel fine sand c
is found in two small areas along t
part of the county. The soil in the
ing of the sandstone beds which co

Owing to the loose structure and
most of the areas mapped as Laure

value. Where a turf of wild grasses has become established the type is of some value as a range for stock.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Laurel fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13677, 14054	Soil	0.1	0.6	3.6	65.4	24.9	3.0	2.3
13678, 14055	Subsoil	.1	1.5	4.2	74.5	16.7	1.4	1.4

WABASH CLAY.

The Wabash clay consists of a heavy, sticky clay, ranging in depth from 0 to 24 inches. The color of the soil varies from drab to jet black, depending on the period of its formation and the amount of organic matter present. The subsoil is also a heavy, tenacious clay, varying in color from gray to black, with occasional faint markings of brownish-yellow.

This type is of limited extent in the county, being found only in a few narrow strips on the bottoms of the Platte and Missouri rivers and in two small areas along Papillion Creek. The largest and by far the most important body of the type is found in the Platte River bottoms, beginning near the mouth of the Elkhorn River and extending 6½ miles to the south in a strip from one-fourth to 1 mile in width. Here the surface foot of the stiff waxy soil is very rich in organic matter, and the jet black color extends to a depth of 40 inches or more.

The Wabash clay is one of the lowest lying soils in the county, and in consequence its drainage is often quite inadequate. In the vicinity of the Platte the type occupies a channel-like depression which winds down through the bottoms between the hills and the foregrounds of lighter-textured soils along the river front. This soil body probably marks one of the former courses of the Elkhorn River, and is still used as a long flood plain by that stream in times of high water. With each successive overflow and its accompanying deposit the elevation of the type is slightly raised, and with each increase in elevation the current, flowing more slowly, deposits a larger proportion of the finely divided materials carried in suspension. These different velocities of the current, corresponding to the different levels of the land, account for the formation of the sand which is frequently found below the fourth foot, and the occurrence of the heavier clays above.

In the Missouri River bottoms the type occurs as low, isolated areas, and may be found near the river or as narrow strips lying near the hills. As a rule, the soil here has been formed by the river backing up and depositing the fine material in its old abandoned channels.

The formation of both soil and s
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deposited during the present seaso
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In such areas the absence of orga
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Owing to its low, poorly draine
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extent of such areas is so small that t

The areas of Wabash clay have
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to the growing of corn and hay, larg
produced. The type commands a p

The following table gives the ave
of samples of this type:

Mechanical analyses

Number.	Description.	Fine gravel.	Coarse sand.
		Per cent.	*Per cent.*
13630, 13681	Soil	0.2	0.4
13631, 13682	Subsoil	.1	.2

WABASH SI

The soil of the Wabash silt loam
and consists of gray, dark-brown,
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Other important areas of the type
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from 10 to 20 feet below the general level of the surface, destructive overflows are occasionally experienced. Much damage is also done by the water from the hills, which pours into these lowlands after every heavy rain. Here tile drains would be especially beneficial in hastening the removal of the water into the channel of the stream. As yet, however, little has been done toward the drainage of this soil.

The origin of the Wabash silt loam is alluvial. Along the rivers it has been formed by the deposition of the fine material carried in suspension by the slowly moving waters in times of overflow, while along the courses of the smaller streams the type has been built up partly by successive overflows and partly by the wash from the higher lying soils.

The structure of this soil is in many places materially influenced by the large accumulation of organic matter which, in the vicinity of the Elkhorn and Platte rivers and along the bottoms of the inland streams, is largely responsible for its deep black color. Along the Missouri, where the formation of the type is of more recent date, the influence of organic material is less pronounced, and in consequence the color is somewhat lighter.

The Wabash silt loam, if properly drained, is one of the best alfalfa soils in the county, though as yet only a few small fields are devoted to this crop. On the drier parts of the type potatoes are extensively grown and do remarkably well, yielding from 150 to 250 bushels per acre. The soil is well adapted to celery, but little attention is given to its cultivation as yet. The chief crop grown is corn, which yields from 45 to 65 bushels per acre, with yields of 80 bushels per acre frequently recorded.

Owing to the successive overflows of the rivers during the last three years probably not more than 40 per cent of the type is now under cultivation, the remainder being used as hay meadow or as a range for stock. The value of the type runs from $70 to $125 an acre, depending on its position and liability to overflow.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Wabash silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13679, 14058	Soil	0.1	0.3	0.2	0.9	13.4	72.9	12.0
13680, 14059	Subsoil	.1	.2	.3	1.3	11.5	72.2	14.2

SARPY CLAY LOAM.

The soil of the Sarpy clay loam is a stiff waxy clay from 12 to 24 inches deep, with an average depth of about 20 inches. The color

AGRICULTURAL METHODS.

Considerable money has been expended throughout the county in the purchase of farm machinery, and the most improved modern machinery is being used in the cultivation of all crops. Corn is the leading crop grown, and the high degree of success which has always attended its cultivation has not lent encouragement to the introduction of new crops.

At the present time the rotation most commonly practiced in the county is a two-years rotation, consisting of corn one year, followed by wheat or oats the next year. The usual method is to plow the grain stubble in the fall for the succeeding corn crop. When the corn has ripened the ears are gathered from the field, while the stalks are left standing and used for pasturage during the late fall and winter months. The following spring the corn land is broken for wheat or oats and in the fall is again plowed for corn. Many farmers are found who plant corn on the same field two years in succession, following it the third year with wheat or oats. A few have introduced a rotation in which clover and grass play an important part. In such cases three or four crops of hay are secured before the land is again used for cultivated crops. This is a commendable practice, and should be more generally followed, especially on those fields which are in danger of washing and on the lighter-textured soils in the river bottoms.

Nearly all of the wheat grown is of the spring varieties, as the severe winters have taught the farmers that the winter wheats are too uncertain to be profitable. Thrashing is done from stacks in the field, and the straw is mostly used for bedding stock.

In the past considerable attention has been given to the production of different varieties of millet, there being in 1900, according to the census of that year, nearly 2,000 acres devoted to these crops. Within the last few years, however, the number of fields sown to clover and alfalfa has reduced to some extent the acreage of these crops.

Only a small amount of commercial fertilizer is used within the county, but the fertilizing value of barnyard manure is quite generally recognized, and the supply is carefully husbanded. It is generally conceded that the most prosperous farmers are those who devote a part of their farms to the raising of live stock, and thus return to the soil, in the form of manure, a large proportion of the material removed from it. With the excellent facilities for marketing stock at South Omaha this could be made a very profitable industry, and should be much further developed.

Along the river flats, in the western part of the county, considerable areas of the poorly-drained soils are given over to the production of wild hay. This, as well as the clover and alfalfa grown on the uplands, is stacked in the field and in the winter is hauled away and used on the farm or is marketed in the loose condition.

AGRICUL

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necessary to retain the services of a man throughout the year, but when this is done the usual wage paid is from $20 to $22 a month and board. Those who contract by the month for shorter periods receive on an average about $23 a month, although as high as $30 a month has frequently been paid.

Sarpy County, lying in the midst of the corn belt, is well adapted to the growing of this crop, and both the yield and quality of the product are excellent. Potatoes return good yields of tubers of fair size and quality and good profits are being made in their production. Along the wet bottoms of the Elkhorn River large quantities of wild hay are annually produced, but the tall, rank grass is considered inferior to alfalfa or tame grasses, and its price is relatively low.

Corn has always been the staple crop of the county, occupying, according to the census of 1900, nearly 49 per cent of the total area under cultivation. It is doubtless true that the marked adaptability of the soils to this crop has done much to place the county in its present condition of prosperity, but the fact should be recognized that this condition can not be maintained indefinitely by continued dependence on this one crop. The practice of alternating wheat or oats with corn should give place to a rotation in which the clovers, alfalfa, and tame grasses form a prominent part. Already alfalfa is beginning to occupy a considerable acreage on the silt loams of the county and the crop is recognized as being of especial value on the Miami silt loam in preventing erosion and in restoring to the soil needed organic matter, which the past methods have caused to be depleted.

More attention should be given to the stock-raising industry, and the feed produced, instead of being sold as such, should be converted into beef and pork before it leaves the farm. By this practice not only would increased profits be derived from the products grown, but the crop-producing power of the soil would be continually increased. The prevailing idea that the Miami silt loam requires more care and attention to maintain its productive power than does the Marshall silt loam is doubtless correct, yet the original crop-producing power of the Miami silt loam was such that with careful treatment its productivity might be indefinitely maintained. Fields of this type were observed which were said to have yielded crops continuously for more than fifty years, yet the average yield of corn in 1904 was over 50 bushels per acre. Such crops are secured by giving live stock a place on the farm and by practicing a rotation of corn, small grain, and grasses.

Dairying is followed to a small extent by a few farmers near South Omaha, the milk being delivered by wagon to consumers in the city. At Springfield a creamery has been established, and the revenue which the farmers are securing from this source is encouraging the development of this industry.

In the northeastern part of the county considerable attention has been given of late to the cultivation of truck crops, of which the most

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county, and in the early part of that year the settlers on Walnut Creek formed a protective association and passed laws that were rigidly enforced, especially those prohibiting the sale of liquor to the Indians.

In 1854 the nearest trading post was St. Joseph, from which both mail and supplies had to be procured. A trading post was established at Iowa Point in 1856, and from this place supplies were distributed to the whole county for two or three years. The first claims were located near the wooded stream bottoms, where logs for building purposes could be easily obtained.

In 1857 the Iowa Indian trust lands lying in Brown County were sold to the highest bidder by the Federal Government. These lands brought extravagantly high prices and were purchased principally by wealthy speculators, the actual home-seeker being content with the rich prairie lands that were his for the asking. In the year following the public lands were sold and many of the preemptors were forced to mortgage their claims and borrow money at a high rate of interest to prevent their property from going into the hands of speculators. Their embarrassed condition at that time was caused by the two successive unfavorable seasons and the lack of markets for even the inferior crops secured.

In the summer of 1859 the excitement created by the discovery of the Pikes Peak gold fields brought many pioneers, who, with their teams, passed through the county on their way to the West. This travel through the county created a demand for corn, butter, and eggs, and those farmers who lived near the "trail" profited by the sales they made.

In the spring of 1860 there was a demand for corn in the new gold fields and many wagon trains were loaded in the county, every farmer selling all the corn he could spare at 25 cents a bushel. The following summer was exceedingly dry and crops failed entirely. Thus many of the settlers were without the necessaries of life and would have suffered but for donations from the East. In the spring of 1861 thousands of bushels of corn and wheat were shipped in from the East to be used as seed, and that year's crops fortunately resulted in abundant harvests.

From 1861 to 1865 prices were high, but the producers were few, the county as yet being only sparsely populated. At the close of the civil war many immigrants made their homes in this county. At this time the Missouri Pacific Railroad Company obtained control of 127,832 acres of the Kickapoo Indian Reservation, the most of which was located in Brown County, and by liberal advertising induced many seekers of homes to locate on their lands. The years 1866, 1868, and 1874 were memorable on account of the grasshopper pest—the grasshoppers being exceptionally destructive in 1874.

The first railroad in Brown
was constructed in 1870. S
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The population of Brown (
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The following tables, compiled from the records of the Weather Bureau stations at Horton and Atchison, show the normal monthly and annual temperature and precipitation and the dates of the first and last killing frosts:

Normal monthly and annual temperature and precipitation.

Month.	Horton.		Atchison.	
	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	*°F*	*Inches.*
January	27.5	1.10	27.5	1.17
February	26.9	1.12	27.2	1.25
March	39.4	1.98	40.0	2.28
April	54.7	2.85	54.9	3.72
May	63.8	4.67	64.4	5.14
June	73.2	4.55	73.3	4.75
July	77.1	4.24	77.3	5.14
August	75.7	4.13	76.5	4.30
September	68.1	3.29	69.1	3.56
October	57.2	1.99	58.2	2.66
November	40.9	1.04	41.6	1.30
December	30.7	1.12	31.2	1.65
Year	52.9	32.08	53.4	36.92

Dates of first and last killing frosts.

Year.	Horton.		Atchison.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1897	Apr. 19	Nov. 2	Mar. 29	Oct. 29
1898	Apr. 7	Oct. 20	Apr. 2	Oct. 17
1899	Apr. 9	....	Apr. 9	Sept. 29
1900	Apr. 13	Oct. 8	Apr. 13	Nov. 8
1901	Apr. 18	Sept. 17	Apr. 18	Sept. 18
1902	Apr. 23	Oct. 14	Apr. 2	Oct. 14
1903	May 1	Oct. 18	May 3	Nov. 6
Average	Apr. 17	Oct. 13	Apr. 11	Oct. 18

From the above table it appears that the growing season for tender crops is about six months.

PHYSIOGRAPHY AND GEOLOGY.

Brown County is situated in the central physiographic division of the United States, and has a general elevation of about 800 feet above sea level. The main divide between the Kansas and Missouri rivers enters the county on the west, about 8 miles south of the Nebraska State line, and runs in a southeasterly direction, leaving the county near Everest. South of this divide the drainage flows into the Kansas, while to the north it flows into the Missouri River. The drainage of the northern part of the county is effected by Pony, Walnut, Lause, and Roys creeks, the eastern part by Wolf Creek and its tributaries, and the southern part by Muddy, Cedar, and some other smaller creeks. Walnut, Wolf, and Cedar creeks are the largest streams in the county.

gravel, and pebble, small areas of bowlder clay, and huge bowlders of the Sioux quartzite, weighing many tons, together with smaller rounded fragments of granite, schists, and other rocks of complex composition are found scattered over parts of the southern and western portions of the county.

This glacial material is a part of the Kansan drift. It is exposed only where erosion has removed the overlying mantle of buff-colored silty material known as loess, which was deposited during later Quaternary time. In the northeastern part the loess is quite thick, but the depth becomes gradually less as the extreme western part of the county is approached, until in the vicinity of some of the streams it disappears, except in small, irregular patches.

SOILS.

Five distinct types of soils were recognized in Brown County. All of these, except the Yazoo silt loam, are upland soils. The name and extent of each are given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.
Marshall silt loam	307,264	83.9
Yazoo silt loam	29,952	8.2
Rough stony land	17,088	4.6
Marshall gravelly loam	10,176	2.6
Marshall sandy loam	2,240	.7
Total	366,720	

MARSHALL SILT LOAM.

The soil of the Marshall silt loam is a dark-brown silt loam, containing from 20 to 30 per cent of clay. The clay content tends to make it rather plastic and heavy when the usual amount of humus is lacking. Where the topography is reasonably level, there is generally sufficient organic matter to produce a mellow, friable, silty loam, easily cultivated and very retentive of moisture.

The subsoil is a heavy silty loam of a somewhat lighter color and heavier texture than the soil. It contains from 25 to 35 per cent of clay and but for the very high silt content would be called a clay loam, and in some instances it is a clay loam. It frequently contains iron concretions, carries an appreciable amount of lime carbonate, and only a small percentage of humus. Where deep exposures are found, the subsoil assumes an ashy-gray to buff color and is composed of very fine sand and silt, with only a comparatively small clay content. The amount of clay seems to decrease below a depth of 3 or 4 feet. The depth of the soil is quite variable, ranging from of the type deficient, and this can usually be remedied with a little expenditure of time and money.

The Marshall silt loam is derived largely from the loessial deposits found generally over the Mississippi Valley. These deposits are composed of the more finely divided materials derived from the breaking down of rocks of almost every description and of many different geological formations. In the western part of the county this soil is in part derived from the weathering in place of limestone and shale, which belong to the Upper Coal Measures. In the process of formation the decay of plants has added to the weathered loess large quantities of organic matter, which imparts to the soil its mellow, friable texture and in no little degree its moisture-holding power. The deeper loess is not essentially different from the surface soil, except in point of organic matter and a slightly lower clay content, and it is due to this fact more than to any other that the Marshall silt loam, when deteriorated by erosion and continuous cultivation, can easily be restored to a high state of productiveness by simply incorporating with the soil liberal quantities of humus and bringing it into proper tilth.

All the staple crops grown in the county—such as corn, wheat, oats, clover, etc.—give the largest yields on the Marshall silt loam. It is especially well adapted to corn and clover. The average yields per acre of the different crops are corn 30 bushels, wheat 20 bushels, oats 20 bushels, and emmer 30 bushels. The usual yield of clover and timothy is from 1½ to 2 tons per acre.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Marshall silt loam:

Mechanical analyses of Marshall silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
11893, 13733, 13735	Soil	0.1	0.4	0.3	0.9	3.8	65.0	29.5
11894, 13734, 13736	Subsoil	.1	.3	.2	.7	2.3	64.8	31.7

YAZOO SILT LOAM.

The soil of the Yazoo silt loam is a dark heavy silt loam, containing from 20 to 30 per cent of clay. It carries a large proportion of organic matter and retains its dark color to a depth of nearly 2 feet, where it grades gently into a subsoil consisting of a dark-brown heavy silt loam of nearly the same mechanical composition as the soil. The subsoil, which is very deep, contains iron concretions in the lower depths and a smaller proportion of organic matter, which gives it an apparently heavier texture than that of the soil.

ROUGH STONY LAND.

The Rough stony land includes the precipitous bluffs and the rough, rocky land along the stream channels, where the covering of loess has been removed by erosion.

The soil varies from a reddish-brown to a bluish-gray silt loam to clay loam, from 0 to 18 inches deep. The subsoil is a silty clay of a gray to brownish color. Its depth varies considerably, being underlain at various depths by limestones and shales. It contains a larger percentage of clay than is found in the soil and generally grades into undecomposed shales and limestones. The type is also characterized by numerous outcrops of shale and limestone. There is considerable lime found in both soil and subsoil.

The Rough stony land in this area is developed by erosion and is always found in the vicinity of the larger streams. Its greatest extent is found in the western part of the county, along Pony and Cedar creeks and around the headwaters of Walnut Creek. Its most typical development is in the northwest part of the survey and embraces the rough, uncultivable lands along the headwaters of Pony Creek. The boundary between this type and the Yazoo silt loam is nearly always marked by a sharp bluff several feet high. On many of the steeper slopes the rocks come to the surface, and here the soil contains a large percentage of limestone and chert fragments. Deep gulches finger out from the streams into the uplands and so thoroughly dissect the type as to render the greater proportion of it uncultivable. The surface is usually very stony, the rock outcrops lying horizontally where erosion has removed the overlying soil.

With the exception of the Yazoo silt loam and a few small areas of the Marshall silt loam, the Rough stony land lies at a lower level than any of the other types. While this type, as a whole, is well drained topographically, still when there is an unusually large rainfall the water soaks down through the more pervious soils of the surrounding types and, encountering the residual substratum of impervious clay, flows out horizontally along the line of contact, causing boggy places in the upland and a water-logged condition on many of the slopes.

The Rough stony land is a residual soil and is derived from the weathering in place of carboniferous limestones and shales. The steep slopes and the impervious nature of the weathered material causes rapid erosion, and the soil is thin on the hillsides and in many instances is removed as fast as formed.

This soil when sufficiently deep is especially adapted to clover and other lime-loving plants. Although not generally cultivated, corn does fairly well upon it, yielding from 30 to 40 bushels per acre. Much of the rougher areas of the type should be seeded with grasses

Excepting areas occurring in the fields of Marshall silt loam little of the Marshall gravelly loam is cultivated.

The following table shows the average results of mechanical analyses of the fine earth of this soil type:

Mechanical analyses of Marshall gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
11891, 13727	Soil	7.5	8.2	4.2	7.8	12.9	34.9	24.5
11892, 13728	Subsoil	8.5	10.6	4.1	8.4	16.2	25.6	26.5

MARSHALL SANDY LOAM.

The soil of the Marshall sandy loam is a dark-colored light sandy loam from 6 to 36 inches deep. Some small gravel are present in the soil, but not in sufficient quantity to influence the type as a whole. The subsoil grades from a buff-colored sandy loam to a sandy clay or silt, sometimes becoming an almost pure sand at from 20 to 36 inches below the surface.

The Marshall sandy loam occurs in the eastern part of the survey along the headwaters of Roys Creek and along the lower part of Wolf Creek. Small spots are found elsewhere in the area.

The surface of the type is much like that of the Marshall gravelly loam; in fact, the two types are intimately associated, both having a common origin—namely, the Kansas drift. Like the Marshall gravelly loam, it is developed by erosion and is most pronounced in places where the silt has been entirely removed from the surface. The two types grade gradually into each other and the boundaries are sometimes difficult to determine.

The Marshall sandy loam produces fair yields of corn and wheat in moist seasons, but in dry seasons it does not do so well, as its open texture tends to make it droughty. This may be remedied in some degree by plowing under clover or cowpeas. From 25 to 35 bushels of corn and from 15 to 18 bushels of wheat per acre are considered good yields for this soil.

The following table gives the results of mechanical analyses of the fine earth of samples of this type:

Mechanical analyses of Marshall sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
13731	Soil	0.5	4.9	12.4	27.5	9.6	23.2	21.9
13732	Subsoil	1.1	2.7	4.3	11.5	9.0	35.7	35.7

HAR

There are several spots and pat
subsoil comes within an inch or t
pan. The most important occu
Powhattan in sections 17 and 1
soil is from 10 to 12 inches deep, u
clay loam from 18 to 20 inches t
silty material that generally forms

These hardpan areas may be eas
of corn on them in wet seasons.
and the hardpan holds the water
become waterlogged. Deep plo
mended as a remedy for this con
also be effective in areas where
likely to result.

AGRICULTU

It is the general opinion of the
average yields of corn, oats, and
from year to year. They say th
work to make a fair crop of corn
the oat crop would not be worth
land and prepare it for wheat.

In view of these facts the farm
crops, and stock raising and dairy
tion. This necessitates the sowi
farmers are experimenting with
as a result emmer, fescue, and
The breeding of seed corn is bec
the results obtained in this direc
average yield of this crop.

The following table shows the t
principal crops grown in the area

Crops.
Wheat, hard
Wheat, soft
Rye
Oats
Barley
Emmer
Corn
Timothy [a]
Fescue [b]
Red clover
Bluegrass
Alfalfa [c]

---

[a] Introduced five years ago.

[b] Intro

As seen from the foregoing table, corn is seeded from April 28 to May 25, when heavy rains are of frequent occurrence. The oat crop is seeded in March and usually on land planted the preceding year to corn. The lister is in general use and most of the corn is planted with it. Comparatively little plowing is done in the preparation of the seed bed of any crop.

Many of the farmers practice a systematic crop rotation which varies with the requirements of each farm. Where land is fairly level and the raising of hogs and cattle is the principal farm industry a seven-year rotation is recommended—clover two years, corn two years, wheat one year, emmer one year, and oats two years.

For hog production probably the best rotation is one in which clover follows corn in short succession. The following six-year rotation is recommended by some farmers: Clover in the spring on fall-sown timothy, mowing the first year and pasturing the second, plowing in the fall; corn the third and the fourth years, followed with oats the fifth year, and wheat the sixth year.

Alfalfa is not used in these short rotations, but is very valuable for permanent meadow, and will become more and more important as the dairying interest increases.

There is much complaint among the farmers of failure in recent years to secure satisfactory yields of oats, as both the blight and rust are very prevalent. It is said that the early growth of the plants is all that could be desired; that the growth of straw is, if anything, too rank. This suggests that it might be better to change the rotations above given and allow wheat, which is not so strong a feeder as oats, to follow corn. The removal of a part of the nitrogen by the wheat crop can be expected to reduce somewhat the rankness of growth in the succeeding oat crop, and, it is believed, make it less likely to suffer from the diseases mentioned.

In preparing the soil for corn the general practice is to use the lister. While in more arid regions this method is to be recommended, there are several serious objections to its use here. The heavy rainfall induces severe erosion in the silty soils at best, and the practice of listing, with the consequent deep furrows and ridges, tends greatly to increase the damage from this cause. In listing, also, the intervals between the rows are broken only to a depth of 3 or 4 inches or as deep as the ordinary cultivator tooth will run. This, of course, increases the surface run off, with consequent increase in erosion. Moreover, the shallow breaking of the soil between the rows tends to interfere with the growth of lateral roots of the corn plants, and this undoubtedly decreases the yield. Deep plowing is one of the most effective means of checking erosion, even on steeply rolling lands, and the fact that it is more expensive to plow the land thoroughly than simply to list the crop in is met by the equally accepted fact

that the protection of the land fr
of corn and of subsequent crops w
expense for preparation of the see

AGRICULTURA

On most of the farms in the cou
and cattle sheds. The price of l
within recent years, but this see
homes by the younger residents o
for profitable investment on the p
among the farmers is that they a
were some years ago. During th
cattle and the ravages of the Hess
profits on many of the farms.

Of the 368,640 acres of land in
and about 88 per cent of these f
the census of 1900 the average size

Less than 50 per cent of the f
and the tenant system is becoming
fact that many of the older reside
is to be expected, tenants do not
up the farms as do those farmers w
sequently in many cases the hedge
deepen, the fences get out of repai
value. The tenant system as at
factory to the land owners.

The use of improved farm ma
county, and many of the farmers
do nearly or quite all the work o
since the demand is not sufficient
employment in this section of the
farmers keep a few hired men, but
his work or exchanges work occas

The principal products are cor
generally consists of timothy and
land are devoted to wild grass
general favor and will soon form
The creamery business is attract
the farmers, thus necessitating the
ing the acreage devoted to pasture

The raising of cattle and hogs
economy of the present farm pr
cattle are either good grades or
mainly of the Duroc Jersey strain.

The farmers generally recognize that the soil type known as the Marshall silt loam is especially well suited to corn, wheat, clover and timothy, alfalfa, and the grasses. Comparatively little study has been made of the other types of soil on account of their topographic position. It is probable, however, that oats will do better on the Marshall gravelly loam than elsewhere and that some varieties of fruit, as apples, would do well on the Rough stony land. The Yazoo silt loam produces good crops of corn, clover, and timothy. Wheat also does well on the well-drained portions of this soil.

The transportation facilities of the county are very good. The St. Joseph and Grand Island, the Missouri Pacific, and the Rock Island railroads put the farmers in direct communication with Kansas City, St. Joseph, Omaha, Chicago, and St. Louis. These cities furnish ready markets for the farmer's produce, the most of which, however, goes to Kansas City. Rural free delivery routes reach all parts of the county, schoolhouses are conveniently located, and the county, as a whole, possesses advantages favorable to a higher development of its agricultural interests.

SOIL SURVEY OF THE CA
DAK

By A. E. KOCHER an

LOCATION AND BOUN

The Carrington area, comprising
lies in the east-central part of Nor
and 99° 15′ west longitude and par
latitude. The area is rectangular
and south and 60 miles east and w
720 square miles, of which 432 sq
Foster County and 288 square mil
townships 145 and 146 north and

HISTORY OF SETTLEMENT AND

Agriculture in the Carrington ar
the first permanent settlement w

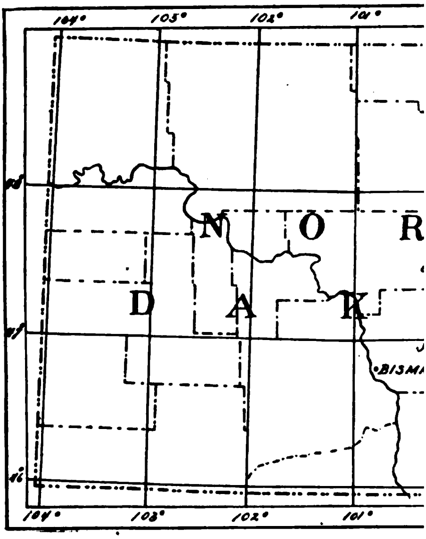

FIG. 40.—Sketch map showing location

Cooperstown. In 1882, when Gr
Cooperstown as its county seat,
Michigan settled in the eastern pa
settlement was greatly encouraged

States survey of the public lands and the building of branch lines of the Northern Pacific Railway from Sanborn to Cooperstown and from Jamestown to Carrington. During this year the towns of Carrington and Melville were founded by people from the east.

An industrious class of Norwegians, Danes, and Swedes, a few years later, settled in the region west of Cooperstown, and have been an important factor in the development of the central part of the area.

From the beginning of agricultural operations in Foster County extensive tracts of land have been held by individuals or by private corporations. One of these large holdings, near Bordulac, has an area of 10,000 acres under cultivation. Aside from this, only a small proportion of the public lands west of the James River had been taken up prior to 1896, but during that year and in 1898 many home seekers from Iowa and Indiana came into the area, and most of the unbroken prairie between Carrington and the river was put in cultivation. Also about this time a thrifty class of Turks and Russians settled in the southwestern corner of the area, among the foothills of the Missouri Plateau, and during their brief occupation of the land they have done much to increase the valuation of what was hitherto considered a very inferior soil.

In the early days the farming class was not so prosperous as in succeeding years, owing mainly to the crude and ineffectual methods practiced during the seasons of excessive drought. Since then all farm methods have undergone a material change. The smoothing harrow and the old-fashioned broadcast seeder attached behind a wagon and drawn across the field have been replaced by the spring-tooth harrow and the modern press drill. These implements, it has been found, make the seed-bed firm and conserve the soil moisture better, lessening the damage caused by long periods of drought.

Wheat, flax, and oats, the crops which held first place in the rotation twenty years ago, are still the dominant crops of the area. There is, however, a decided tendency to introduce some new crops. Corn, a needed cereal, is beginning to be grown, and alfalfa, clover, and the tame grasses have been lately introduced with success.

CLIMATE.

The climate of the area is quite varied. In the winter the temperature sometimes falls to 50° below zero, while in the summer it has been recorded as high as 107°, giving an extreme range of 157°. The summer months are usually very pleasant, the temperature rarely rising above 90°, and the nights are usually cool.

The spring and fall months are usually characterized by high winds, which, beginning in the morning, increase in force until about 2 o'clock p. m., then gradually slacken and abate with the setting of the sun.

There is only one Weather Bure is located at Melville, but for purp the Jamestown and Devils Lake st

The following table shows the r perature and precipitation:

Normal monthly and annual tem

Month.	Melv
	Temperature.
	°F.
January	12.0
February	6.0
March	26.0
April	43.0
May	55.0
June	62.0
July	62.0
August	64.0
September	54.0
October	43.0
November	26.0
December	11.0
Year	38.8

Notwithstanding that the norm especially as recorded at the Melv large proportion of it comes in the amount sufficient for crop product

According to the records of th normal annual precipitation for the the months of May and June, and t November 1 to April 1 has been figures are somewhat more striking Lake and Jamestown stations, and extent the conditions in the easter the fact that the average snowfall

From data relating to the dates and the first in fall, as afforded by Bureau stations, the average date and in fall September 12. The ave based on frost occurrences during at Melville and Jamestown and 1

PHYSIOGRAPHY

The topographic features of the teristic of glaciated regions. Tw extending in a northerly and sou into three distinct and comparatively level tracts. One of these moraines, occurring in the vicinity of Cooperstown, has an average width in the area of about 4 miles, although just before crossing the northern boundary, its course becoming east and west causes it to occupy the northern tier of sections in both Cooperstown and Clearfield townships. In this locality the topography is rough and broken, the hills rising abruptly from the plains to a height of 30 to 100 feet. South of Cooperstown the morainic belt becomes narrower and the hills less pronounced.

East of this region to beyond the limits of the area extends a gently undulating plain, through which the sluggish Sheyenne River crosses the area from north to south. Here the valley, cut in glacial times, has an average width of about one-half mile and lies 100 feet or more below the level prairie. With the exception of one big bend the course of the river in the main is straight, but its feeble current along the level bottom causes it to wind from side to side of the valley. In the southern part of the valley are several old channels marked by sloughs and shallow lakes, through which the river still flows in times of high water.

The second and more important moraine is found just east of the center of Foster County, where it occupies probably 100 square miles of the area. Geologically this region is known as the Fourth or Kiester moraine, and is of interest here in that it forms the high walls of the glacial valley of the James River. Although about equal parts of this moraine lie on each side of the river, yet in surface features they present a striking contrast. East of the river for about 4 miles the country consists of rounded hills and low ridges, separated from each other by gently sloping tracts. The altitude varies from 1,500 to 1,560 feet above sea level and from 20 to 60 feet above the prairie to the east. West of the river the surface of the first 2 miles is rough and broken in the extreme. The elevation varies from 1,520 feet, the level of the prairie, to 1,690 feet near the northern limit of the area. The valley of the river, with an altitude of 1,430 feet, lies about 100 feet below the level of the prairie and 260 feet below the summit of the moraine.

East of the James River, between the two morainic belts already described, there is a gently rolling plain constituting about one-third of the entire area mapped. Near its eastern edge this plain is cut in a southeasterly direction by the deep channel of the Baldhill Creek. At the present time this stream is small and unimportant, but when the glacier's edge stood a few miles to the north, where now the moraine belt is found, a mighty river hurried down its course, cutting out the broad, deep valley with the waters from the ice.

The remaining great physical division of the area extends westward from the moraine along the James River to the foot of the Missouri

The following table gives the average results of mechanical analyses of samples of the Marshall silt loam:

Mechanical analyses of Marshall silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12923, 13409, 13411.	Soil.........	1.2	3.5	2.5	10.5	13.3	50.3	18.7
12924, 13410, 13412.	Subsoil.....	1.3	5.0	3.0	11.0	14.0	42.9	22.7

CLYDE LOAM.

The soil of the Clyde loam is of a varying texture, ranging from a dark-brown loam to black clay loam, with an average depth of 10 inches. The subsoil is usually a gray or drab-colored clay to a depth of 30 inches, below which are frequently found thin layers of coarse sand.

A phase of the type of quite common occurrence consists of a black, heavy sandy loam, underlain at from 4 to 10 inches by a sticky white silty clay.

The Clyde loam is of wide distribution throughout the area, occurring as numerous low depressions ranging from a few rods in extent to several hundred acres. The type marks the location of old lake beds, which, lying below the general level of the prairie, are always poorly drained. Around the margin of these old lakes well-marked beaches frequently occur from 5 to 20 feet in height, composed of coarse sand, gravel, and large glacial bowlders. This sandy, wind-blown material has greatly changed the texture of the soil in some of the smaller depressions.

For centuries these lake beds have received the drainage of the surrounding prairie and having no outlets the only avenue for the removal of the waters was by evaporation. Thus the salts held in solution by the waters of the lake were left behind and have collected in the lowest places as a white efflorescence on the surface. However, only rarely is alkali encountered in sufficient quantities to interfere seriously with the growth of native vegetation. The soil is frequently too wet for cultivation, and only about 1 per cent of the type has yet been broken up. Where alkali is found on the cultivated areas, the application of barnyard manure has greatly improved the structure of the soil, allowing the rains to carry the salts into the lower depths beyond the reach of the shallow-rooted crops.

The type in favorable seasons supports a luxuriant growth of native grasses; but if the rains come late in the spring the grasses do not make a vigorous growth, and in some years when ready to be cut for hay many of the areas are so wet as to prevent the harvesting of the crops. The greater part of the land of this type is held at about $15 an acre.

The following table shows the av
of typical samples of the soil and s

Mechanical anal

Number.	Description.	Fine gravel.	Coarse sand.
		Per cent.	*Per cen*
13415, 13417	Soil	1.0	1.
13416, 13418	Subsoil	1.2	4.

MARSHALL

The Marshall fine sand is an i
sand, slightly loamy on account
grading at 12 to 16 inches into
sand, and this in turn, at 24 inch
sand of fine to medium texture.

The type occupies gently rollin
cial in its origin, being deposite
carried by their waters. Most of
vicinity of river courses. The l
of the Sheyenne River and in T.
of Baldhill Creek. A few small
the area.

The soil, on account of its loo
the wind, being carried someti
often found in dunes from 2 to
materially damaged by these san
spring about the time the youn
shoots.

Only a small percentage of th
vation. The native vegetation
heavier prairie soils, and, except
are rather poor, ranging from 6 t
bushels of wheat, and from 20 t

The value of this type of soil va
ing upon its location and proxim

The following table gives the
typical samples of the soil and su

Mechanical analyse

Number.	Description.	Fine gravel.	Coarse sand.
		Per cent.	*Per cen*
12921	Soil	0.3	1.
12922	Subsoil	.3	1.

MARSHALL FINE SANDY LOAM.

The Marshall fine sandy loam, to an average depth of 14 inches, is a dark-brown or black loam or fine sandy loam, the color being due to the presence of organic matter. This is underlain with a yellowish-brown fine sandy loam less coherent in structure, grading at 20 inches or more into a yellow fine to medium sand, extending several feet in depth. Overlying the coarser material of the subsoil is often a thin stratum of shale, which when decomposed contains a small percentage of bluish-gray clay. This is particularly true of the large body of this type in T. 146 N., R. 60 W. The subsoil is also frequently a loam.

The Marshall fine sandy loam usually occurs in small patches, the largest continuous bodies being in T. 146 N., R. 60 W., and R. 61 W. In the former the texture of the soil is coarser than in other parts of the area. Disconnected bodies of the type also occur in T. 146 N., R. 61 W., and R. 62 W., and in the vicinity of the Sheyenne River and Baldhill and Pipestem creeks. Another area, occupying parts of three sections, is found south and west of Melville. The type usually occupies gently undulating prairie or small morainic hills or plateaus. It frequently occurs also in narrow bands encircling old lake beds and along stream courses, but these were not of sufficient extent to be shown on the accompanying map.

The soil is of glacial origin, although the winds may have been a factor in its deposition. In the vicinity of the streams or between them and the series of moraines to the north of the area it is reasonable to suppose that this soil was deposited as overwash from the melting of the ice of the glaciers or carried down by the waters off the moraines themselves.

Owing to the fairly loose structure of both soil and subsoil and location in the vicinity of stream courses and old lake beds, the Marshall fine sandy loam is naturally well drained, but it is sufficiently compact to retain enough moisture to withstand drought. In extreme wet or dry seasons it frequently gives better yields of grain than the heavier types, and the crops are less susceptible to rust, but in average seasons the yield is less. The type is particularly well adapted to Irish potatoes, the yields being from 150 to 250 bushels per acre. Corn also does well on this soil, but is grown only in small gardens for home use. Each of the cereals grown in the area is found upon the Marshall fine sandy loam, with average yields per acre, as follows: Wheat, 10 to 15 bushels; flax, 6 to 10 bushels, and rye, barley, or oats, 25 to 30 bushels.

Land of this type ranges in price from $20 to $30 an acre.

The following table gives the average results of mechanical analyses of typical samples of soil and subsoil of the Marshall fine sandy loam:

Mechanical analyses of Marshall fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12801, 13403	Soil	1.7	11.1	9.1	28.3	17.2	21.1	11.2
12802, 13404	Subsoil	.6	5.7	7.8	27.0	15.4	32.1	11.1

WABASH CLAY.

The soil of the Wabash clay consists of a dark-brown or black clay loam or clay, with an average depth of about 12 inches. The subsoil is usually a black heavy clay, from 12 to 30 inches deep, underlain to a considerable depth by a light-brown clay of the same texture. The soil is tenacious and rather difficult to work, especially in the spring, when it is often saturated by the seepage waters from the higher levels.

The Wabash clay, averaging one-half mile in width, is found along the lowest portions of the Sheyenne River Valley. In the northern part of the valley, where the type lies chiefly on the eastern side of the river, there is a gentle slope from the higher elevation to the water's edge, but farther south, where the strip becomes more narrow and follows more nearly the river's course, the surface is quite low and level. In this level portion, where the water sometimes saturates the soil, open ditches could be dug or tile drains laid with profit. The greater part of the type, however, is well drained and under a fair state of cultivation.

The Wabash clay is of alluvial origin, having been formed by the deposition of the fine particles washed down from the heavy Hobart clay of the adjoining hillsides.

The heavy texture of the soil and its low-lying position along the river, insuring sufficient soil moisture for crops to withstand drought, make the type admirably adapted to small grains and tame grasses, although the latter have not yet been extensively introduced. Wheat, under favorable conditions, yields from 20 to 35 bushels per acre, oats from 35 to 70 bushels, and flax, rye, and barley do remarkably well.

Along the course of the river and the old glacial channels which wind through the valley, occurs a narrow strip covered by a dense growth of oak, ash, and elm. This growing timber, in a region where fuel is so scarce, makes this type of soil one of the most valuable in the area, and because the valley is so badly broken into by the tortuous channel of the river, this portion of the type is probably more valuable in its present state than it could possibly be under cultivation.

The price of the land ranges from $30 to $40 an acre, depending upon improvements.

The following table shows the average results of mechanical analyses of samples of the Wabash clay:

Mechanical analyses of Wabash clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13000, 13421	Soil	0.2	1.3	1.2	5.6	6.7	48.2	36.3
13001, 13422	Subsoil	.1	1.1	.8	3.2	4.4	35.1	55.1

HOBART CLAY.

The Hobart clay, though small in extent, may be said to have three distinct phases, depending upon the declivity of the bluffs along which it occurs.

At the top of the bluff the soil consists of from 0 to 6 inches of brown clay loam, underlain to about 4 feet by dark-drab or slate-colored clay. Along the steeper part of the hill and that portion of the valley where erosion has been most active the clay loam has been entirely washed away, leaving the stiff, waxy, slate-colored clay exposed. At about the fourth foot the subsoil begins to pass gradually into shale, which soon gives place to the unweathered Cretaceous rock. On this phase of the type the surface is usually thickly strewn with large glacial bowlders. Nearer the valley, where the slope is more gentle, the soil consists of about 10 inches of friable clay loam, underlain to a considerable depth by black plastic clay.

The Hobart clay occurs along the precipitous bluffs of the Sheyenne River and the steep-sided coulées leading into it. Of the eroded phase the most typically developed area is found 5½ miles southeast of Cooperstown, where the slippery clay and decomposing shale slide down the hill with every heavy rain, leaving the surface devoid of any vegetation.

Owing to its position, the stiff, waxy nature of the soil, and the numerous glacial bowlders scattered over the surface, only that phase of the type which occupies the lower portion of the hill can be used for cultivation. Such a strip occurs near the northern boundary of the area on the east side of the river, and fine yields of all the small grains are annually produced. Where the Hobart clay is under cultivation the land is held at about $30 an acre, but the greater part of the type, used only for pasture, is valued at from $10 to $15 an acre.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of Hobart clay:

Mechanical analyses of Hobart clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13026, 13395	Soil	2.9	6.9	3.9	12.4	4.4	30.9	38.4
13027, 13396	Subsoil	1.4	4.9	2.1	4.1	1.9	17.4	67.8

WA

The Wabash loam, from 0 t friable loam, with a considera underlain by a subsoil usually soil, but becoming somewhat lig

Only a few small areas of V occurring as narrow strips witl type occupies the more gently s intermediate type between the the Wabash clay of the valley fl where the stream approaches th down the slope to the bank from 5 to 30 feet above the higl

The Wabash loam is one of t yet rarely suffers from the efl formed from the materials wash and the prairie types adjoining origin, and owing to its positio the rains bring down materials f previously deposited.

The Wabash loam is a very pı lent drainage features and the is well adapted to the productic the lack of convenient market grow these crops, except as the

Practically all of the type is Wheat yields from 18 to 25 bu years as high as 35 bushels hav 35 to 65 bushels per acre, and th type is valued at $30 an acre.

The following table shows th Wabash loam:

Mechanical an

Number.	Description.	Fine gravel.	Co sa
		Per cent.	*Per*
13419	Soil	0.8	
13420	Subsoil	.8	

CARRING

The Carrington clay loam in 0 to 10 inches of dark-brown to with yellowish-brown silty an depth the material is a brownis layer of coarse sand. This pl valley of Pipestem Creek and t the area. Its origin is largely sedimentary, the material having been left by the waters of the stream or deposited as beds of former lakes.

The upland or prairie phase of the Carrington clay loam is a brownish-yellow silty clay with an average depth of about 10 inches. The subsoil ranges from material of the same texture and color to stiff, tenacious dark-gray clay. Between the third and fifth foot strata of reddish-yellow sand are frequently encountered, containing varying quantities of calcium carbonate, gypsum, and iron sulphate. The soil when wet is sticky and plastic and presents all of the objectionable features of "gumbo," making it a difficult soil to till.

The type is of comparatively limited extent, being found only in small bodies in townships 145 and 146 north and ranges 66 and 67 west, inclusive. South of Carrington, along the Devils Lake branch of the Northern Pacific Railway, occurs the most typical area of the prairie phase of the type. Here small irregular areas are frequently found from which the original prairie sod has been removed. This condition is commonly believed to have been caused by early prairie fires, and although it may be due to other causes there was not time to investigate this question sufficiently to determine the point definitely. On most of these areas a new sod has been developed, but the vegetation makes a feeble growth at best.

The Carrington clay loam is the only soil in the area seriously affected with alkali. Practically all of the type contains some salts, though not in sufficient quantity to interfere seriously with the growth of native grasses. Only about 1 per cent of the type is under cultivation, and in the cultivated fields small places are occasionally found, ranging from a few rods across to 2 or 3 acres in extent, where the alkali has risen and formed a white crust on the surface. On such spots vegetation has been entirely killed out.

The most effective way to correct permanently the alkali conditions in this soil is by the construction of an artificial drainage system. Deep open ditches are a necessity, as the structure of the soil is such as to preclude the probability of satisfactory results by the use of tile drains. The structure of this soil has in many instances been much improved by the application of barnyard manure, the injurious effects of the alkali having disappeared and the soil made to produce good yields of grain the second season following manurial treatment.

This type of soil is valued at from $9 to $15 an acre.

The following table shows the average results of mechanical analyses of samples of this soil:

Mechanical analyses of Carrington clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13386, 13389, 13392.	Soil	1.3	3.2	3.6	13.6	15.4	31.4	31.0
13387, 13390, 13393.	Subsoil	.9	2.8	3.5	15.7	19.1	31.0	26

The surface of the Marshall stony loam is naturally very rough and broken, a common feature being the frequent occurrence of "hay sloughs" surrounded by irregular hills. Much of the soil has excessive drainage, as the slight rainfall, instead of being retained on the steep hillsides, quickly runs off and is lost in the heavier soils of the depressions.

The origin of the type is purely glacial, the high moraines and long, smooth swells and ridges marking the place where the edge of the melting ice sheet halted in its slow retreat across the area.

One phase of the Marshall stony loam consists of large stones embedded in coarse sand and fine gravel. This phase occupies the summits of the higher hills or occurs as narrow strips around the margins of old lakes. In either case it has no agricultural value. In a few instances, where the stones appear only on the surface, the owner has removed them, and when this is done the soil is fairly productive. However, only a small per cent of the Marshall stony loam is under cultivation, it being considered more profitable to utilize the type for grazing purposes than to attempt cultivation, which can only be done after removing the stones.

Along the James River the hills support at nominal cost throughout the summer a herd of several hundred cattle, and a considerable income is realized by some of the farmers from the cattle industry.

The value of the Marshall stony loam varies from $8 to $15 an acre, depending upon location and topography.

The following table gives the results of mechanical analyses of typical samples of the Marshall stony loam:

Mechanical analyses of Marshall stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13397	Soil	7.7	12.8	7.3	19.4	14.7	24.3	13.9
13398	Subsoil	4.7	11.8	7.4	18.3	15.0	23.5	19.3

MEADOW.

Meadow is composed largely of coarse sand, underlain at varying depths with gravel, shale, and cobblestones. In some localities the soil contains a small amount of silt and clay, overlying always a subsoil of loose texture.

The type occurs in small irregular areas along the present courses of the streams and the unused waterways of glacial times.

Along the James River, near the northern boundary of the area, occurs about 1,600 acres of the type, of which nearly one-half has been put in cultivation. During wet seasons fair crops of grain are produced, but the frequent occurrence of large, glacial bowlders on the surface interferes to a great extent with cultivation. From this body down through the valley extends a narrow strip, in which occur a few small areas of very desirable soils, adapted to the usual crops grown, but these were of too small extent to be classified as a new type.

In the southwestern part of the area another extensive body of Meadow is found deposited as glacial wash on the more gentle slope at the foot of the Missouri Plateau. Here the loamy material, from 10 to 15 inches deep, gives the type the appearance of good, productive soil, but the underlying gravel and cobblestones make it very susceptible to the effects of drought.

The type, whether cultivated or used for pasture, is valued at from $10 to $15 an acre.

The following table shows the results of mechanical analyses of samples of the Meadow:

Mechanical analyses of Meadow.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13022	Soil	3.2	30.6	20.6	14.3	4.3	11.3	15.1
13023	Subsoil	9.2	43.0	25.9	13.3	.9	2.4	5.2

ALKALI IN SOILS.

Alkali in injurious quantities was found only in the southwestern part of the area. The small bodies of Carrington clay loam, which occur south and west of Carrington, are all more or less impregnated with alkali, though this is the only soil in the area which is seriously affected. Only portions of these bodies contain alkali in sufficient quantities to prevent the growing of ordinary crops. These strongly impregnated spots, occurring usually in the center and lowest portions of the type, vary in size from a few rods across to 2 or 3 acres in extent, and are commonly marked either by badly stunted crops or by the entire absence of vegetation.

Samples of the soil and subsoil were taken from the worst alkali areas, and the character and quantity of the salts present determined in the chemical laboratory of the Bureau. The results of the analyses, given here in tabular form, show that the salt content in these areas is sufficiently high to interfere with the growth of ordinary crops. The principal salt found is sodium sulphate, although there are also present considerable quantities of sodium carbonate, a salt especially harmful to plant growth. The total area sufficiently affected by alkali to prohibit plant growth probably would not exceed 300 acres.

Although these analyses indicate the presence of excessive quantities of injurious salts, the areas so affected were so few and of such small extent that the construction of a special alkali map for the area was not deemed advisable.

Chemical analyses of alkali soils.

Constituent.	Number 13387, subsoil of 13386, 10 to 36 inches.	Number 13388, subsoil of 13386, 36 to 60 inches.	Number 13390, subsoil of 13389, 10 to 40 inches.	Number 13391, subsoil of 13389, 40 to 60 inches.	Number 13392, soil 0 to 10 inches.	Number 13393, subsoil of 13392, 10 to 40 inches.	Number 13394, subsoil of 13392, 40 to 60 inches.
Ions:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Calcium (Ca)	1.95	0.62	2.14	1.21	....	0.52	....
Magnesium (Mg)	2.21	4.96	....	3.12	1.39	1.31	4.31
Sodium (Na)	23.47	17.36	24.64	24.78	27.33	27.71	18.10
Potassium (K)	2.43	6.61	5.00	1.04	1.78	1.05	7.33
Sulphuric acid (SO_4)	45.82	45.45	42.15	54.77	38.41	50.98	29.75
Bicarbonic acid (HCO_3)	24.12	25.00	26.07	12.65	28.71	18.43	36.63
Chlorine (Cl)	....	....	....	2.43	....	....	....
Carbonic acid (CO_3)	....	....	....	....	2.38	....	3.88
Conventional combinations:							
Calcium sulphate ($CaSO_4$)	6.42	2.07	6.79	4.15	....	1.96	....
Magnesium sulphate ($MgSO_4$)	10.62	24.17	....	15.57	7.33	6.54	22.31
Sodium sulphate (Na_2SO_4)	48.66	36.58	55.35	57.44	48.32	65.60	17.60
Sodium bicarbonate ($NaHCO_3$)	27.88	20.24	24.64	14.71	39.60	23.16	45.49
Potassium bicarbonate ($KHCO_3$)	6.42	16.94	13.22	2.94	....	2.74	5.58
Sodium chloride (NaCl)	....	....	....	5.19	....	....	....
Sodium carbonate (Na_2CO_3)	....	....	....	....	1.78	....	....
Potassium carbonate (K_2CO_3)	....	....	....	....	2.97	....	9.02
Per cent soluble	.45	.48	.28	.58	.51	.77	.23

AGRICULTURAL METHODS.

Since the beginning of agriculture in the area the principal crops have been wheat, flax, oats, and barley, and as all of these, excepting flax, are sown early in the spring, the short period between the thawing of the soil and the time for seeding makes it necessary to do much of the plowing in the fall. In the spring it is customary to go over the ground with a disk and a smoothing harrow, after which the field is seeded with a press or shoe drill. Thrashing is done almost entirely from the field, the grain being at once delivered at the elevator, or, in some cases, held on the farm to await shipment later.

As yet no systematic rotation of crops has been established. One of the best rotations, according to some of the most progressive farmers, is wheat two years, followed by barley, flax, rye, and oats.

During the last three years winter rye has been grown by some with much success, the practice being to drill it into the flax or oat stubble in the fall without replowing, or into wheat stubble where the ground was prepared late the spring preceding. Thus the young grain during the winter receives the protection afforded by the snow, which, lodging in the stubble, is not blown away. By this practice larger yields are obtained than from the spring seedings and the crop is harvested in time to permit of summer plowing, thus eliminating the loss occasioned by an idle field during the entire season.

Too little attention is given to the manurial requirements of the land, and the injurious practice of growing wheat after wheat without returning anything to the soil is plainly noticeable on some of the older fields in the area. During the first few years after breaking the rich prairie sod the natural store of decaying organic matter is ample for crop production, but as cultivation continues and this humus is removed something must be added to take its place. This may not now appear essential, for the country is yet new and much of the soil still retains its original productive power, but the experience of the past has taught the wisdom of husbanding the resources of the soil rather than restoring them after it has deteriorated. The best and cheapest fertilizer for maintaining the productiveness of the soils of this area is well-rotted barnyard manure. Especially is this needed on some of the lighter soils, from which much of the organic matter has already disappeared. Care should be taken, however, to have the manure decomposed, lest the coarse litter make the soil too loose to retain sufficient moisture during periods of excessive drought.

AGRICULTURAL CONDITIONS.

The interests of Griggs and Foster counties are distinctly and exclusively agricultural. From one end of the area to the other, a distance of 60 miles, the energies of the people are directed toward the production of small grains. Except among the hills along the James River and the region south and west of Carrington, where settlement has been more recent, the farms are characterized by modern dwellings and large, commodious barns. Public roads have been laid out around every section in the area, and during the last few years considerable attention has been given to their improvement. The work horses are large and serviceable, and the farm machinery of the latest improved type. Improved breeds of cattle have been introduced, and on every hand are evidences of industry and thrift.

The prosperity of the region is strikingly shown by the rapid increase in the value of the lands. Ten years ago, in the vicinity of Cooperstown, unbroken prairie land could be bought at from $5 to $8 an acre, and improved farm land at from $10 to $12 an acre. Now what little remains of the unbroken prairie sells for from $15 to $26 an acre, while improved lands command from $25 to $40 an acre. While in Foster County land values have steadily increased, they have not yet quite reached those in the eastern part of the area. In Foster County, within the limits of the area mapped, are 14,000 acres held by the State as school land, of which the average price is $11.50 an acre. Improved lands in Foster County are valued at from $20 to $30 an acre.

Only a small proportion of the land is occupied by tenants, who, as a rule, are intelligent and industrious farmers. According to the census of 1900, 73 per cent of the farms in Griggs County and 77.5 per cent of the farms in Foster County are operated by the owners. Since then, it is generally conceded, the tenant class has been getting smaller, due mainly to the fact that many of this class are acquiring farms of their own. The farms are rented on what is known as the crop-payment plan, by which the owner, furnishing one-half the seed and paying one-half the thrashing bill, receives one-half of the crop, or, furnishing nothing but the land, receives one-fourth of the grain delivered at the elevator.

Although there is a tendency toward smaller farms and better cultivation, there are still a few large holdings in the area. One of these near Bordulac is said to contain 16,000 acres, of which 10,000 acres are in a fair state of cultivation. There are many farms of from 600 to 2,000 acres. The census of 1900 gives the average size farm for Griggs and Foster counties as 427.6 and 437.9 acres, respectively.

The chief problem confronting the farmers of the area is that of securing efficient labor during the busy season of the year. Even the smaller farmers at such time are compelled to hire at least one man. Usually the wage for harvest hands ranges from $1.75 to $2.75 a day and board. While the hired laborers at this season are mostly of the transient class, they are more efficient than were those with whom the farmer dealt ten years ago. Only a few of the wealthier farmers are obliged to hire help the year round. These pay on an average about $20 a month and board. The greater number hire on what is known as the eight months' plan, from April 1 to December 1, paying from $20 to $30 a month and board. Many of this class of laborers soon acquire homes in the locality where they work.

Until recently all of the hay has been obtained from the wild grasses of the prairie and the coarse material of the sloughs. While the hay thus secured is nutritious, it does not equal that obtained from the meadows of tame grasses, and as nearly all the prairies are now broken up and the weeds are crowding out the wild hay in the sloughs the cultivated grasses are being slowly introduced to take its place.

Since the drought of the early eighties the area has been comparatively free from the ravages of pests which have damaged the crops in other regions. In 1904, however, the black stem rust appeared, which caused an estimated loss in Foster County of at least 15 per cent in the common varieties of spring wheat grown, and in Griggs County the loss in yield of these varieties was variously estimated from 25 to 50 per cent of the entire crop. Though the disease may not occur again in several years, this experience should teach the farmer to be on the alert to adopt a practice which, in case it should return, will prevent serious loss. The black stem rust[a] of wheat may exist in two stages. The first, known as the red-rust stage, causes little if any damage to the crops. The second stage, known as the black rust, causes the shrinkage of the grain, and hence the damage. It is sometimes possible by careful cultivation and the selection of the early varieties for seed to have the grain ripen before the worst attack of the black-rust stage is encountered. It has been found that the durum varieties are without doubt the most rust-resistant wheats now grown. Among these varieties the Iumillo, Velvet Don, and Arnautka are said to take the lead. Although the price ranges from 12 to 15 per cent below that of the common varieties, the fact that the average yield is 20 per cent more makes them valuable varieties to grow.

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[a] Lessons from the Grain Rust Epidemic of 1904. Farmers' Bulletin No. 129, by Mark Alfred Carleton.

From the beginning flax has been considered one of the most profitable crops grown in the area. This is due in part to the fact that a good crop can be secured on the newly broken prairie with much less tillage than the other crops demand. It is, however, so exhausting to the soil that it is never wise to attempt to grow two crops in succession on the same piece of land, but they should be placed as far apart as possible in the rotation practiced on the farm. During the last few years this practice has been necessitated by the appearance of a disease known as flax wilt, which materially affects the yield of the crop if grown on the same field two or more years in succession. For this reason, and because so much of the original prairie is already broken up, leaving no new land available for flax, the acreage of the crop during the last few years has been materially decreased.

In the greater part of the area only the seed of the plant is utilized. However, tow mills have been established at Cooperstown and at Kensal for working up the straw into upholstering material; but the price paid for straw—$2 per ton—is so small that only the near-by farmers find it profitable to deliver it to the mill.

All through the area there is an apparent lack of appreciation of the adaptation of soils to crops, and in the past the economy of the farm has been characterized by the struggle to cultivate the greatest acreage of grain without regard to the quality of the land. Timothy, brome grass, alfalfa, and red clover all do well, though as yet little experience has been had in their cultivation. More live stock should be raised and more alfalfa grown. The Marshall silt loam, where good subdrainage can be had, is well adapted to the growing of alfalfa. Corn, while not always a success, is succeeding better every year, and it is thought that within a few years, as a result of the work of acclimation, this crop can be grown with a fair degree of success. During the past year a number of the more hardy fruit trees have been introduced, but the growing of orchard fruits is still in the experimental stage.

Excepting the western part of Griggs and the eastern part of Foster County, the transportation facilities of the area are good. Carrington, the principal shipping point of the western part of the area, is located at the junction of the Devils Lake and Sykeston branches of the Northern Pacific Railway, connection being made with the main line at Jamestown. Through Carrington also passes the main line of the Minneapolis, St. Paul and Sault Ste. Marie Railway, forming a direct route to both the Northwest and the cities of the East. The Cooperstown branch, leaving the main line of the Northern Pacific at Sanborn and passing north through Cooperstown, gives excellent transportation facilities to the eastern part of the area. These railway lines place the area within easy reach of the great grain markets of Minneapolis, St. Paul, Superior, and Duluth.

SOIL SURVEY OF T
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By J. GARNETT H

LOCATION AND

The Grand Valley lies to t
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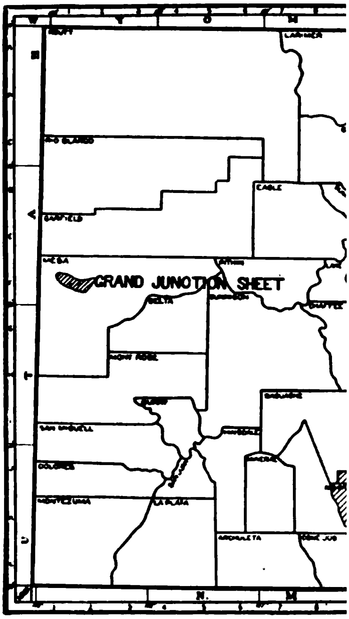


FIG. 41.—Sketch map showin

HISTORY OF SETTLEMEN

The agricultural resources
oped before 1882, as the cou
the outside world, and the n

small tracts near the river. In 1882 the Denver and Rio Grande Railroad was extended to Grand Junction, and the first steps were taken to construct a large irrigation system to bring under cultivation the arid lands of the valley. The main line of the Grand Valley Canal was completed by 1884, and the high line lateral, the Mesa County Ditch, and the Ranchman's Independent Ditch were well under way. After several changes of ownership all these canals passed into the hands of a single company controlled by the Travelers Insurance Company. Corporation management did not prove a success, and in 1894, the company having become involved in legal and financial complications, the entire canal system was sold to its water users, who have since operated it under the title of the Grand Valley Cooperative Association, the stock being owned by the farmers, each in proportion to the amount of water required to irrigate his land. As it has never been necessary to economize on water in Grand Valley, 1 miner's inch, or 1.56 cubic feet, per minute, has been allowed the owner to irrigate 2 acres of land. Since organization the affairs of the company have been well managed, and general satisfaction has prevailed among the water users. The annual assessment for running expenses and repairs has averaged about 65 cents per acre.

The water for the Grand Valley system is taken by gravity from Grand River, about 1 mile south of Palisades. The entire system is 46 miles in length, and has a capacity for irrigating over 25,000 acres of land. The Keiffer extension, in the western end of the valley, is not controlled by the Grand Valley Irrigation Company, but is dependent upon that company for its water.

The irrigation system second in importance is that put into service in 1892 by the Palisades Irrigation District. Water is taken by this company from the extreme eastern end of the valley above Palisades and distributed over a strip of land lying north of the area covered by the Grand Valley system. There are two main canals, 34 and 80 feet, respectively, above the level of the river, to which water must be raised by pumps. The pumps are operated by the water power of a 16-foot fall, obtained by a diversion canal from Grand River. Repairs to machinery, damage by high water, and other expenses have brought the total cost of this plant to $75,000, but it could be duplicated for much less. The annual assessment for maintenance of the canals and pumps has been about 75 cents per acre.

The only irrigation project south of Grand River that has been entirely successful is the small canal used to irrigate the river bottom opposite the town of Palisades. Water is lifted 26 feet by a 50-horsepower steam engine. The fuel used is waste coal from the mine near at hand, which is obtained at a very small cost. The capacity of the plant is 650 standard inches, or sufficient to irrigate four times the amount of land under the canal.

lent crop of peaches, while in other parts the trees were totally devoid of fruit. This question of local climatic conditions has not received the study that is necessary to determine definitely its significance, but the experience of peach growers has been that in the vicinity of Palisades there have as yet been no freezes to kill the buds. Along the northern edge of the valley there is a high, precipitous ridge that extends from the eastern limits of the valley to about 5 miles west of Palisades. In the area between this ridge or bluff and the river bottoms the people have no fear of a failure of the peach crop.

Winter temperatures often go below zero throughout the valley, and in summer the thermometer often registers 85° to 90° F. in the shade. Compared to other parts of Colorado the summers are warm, but owing to the dryness of the atmosphere but little discomfort is experienced from high temperatures.

Strong winds occasionally sweep across the valley, but destructive storms of any kind are unknown. The rainfall is slight and is not relied upon in any way as a supplement to irrigation in the growing of crops.

The following tables give the dates of the first and last killing frosts in fall and spring and the mean annual temperature and precipitation as taken from the Weather Bureau records for the stations at Grand Junction and Collbran:

Dates of first and last killing frosts.

Year.	Grand Junction.		Collbran.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1897	Apr. 12	Oct. 27	....	....
1898	Apr. 5	Oct. 17	....	....
1899	Apr. 19	Oct. 16	....	....
1900	Mar. 28	Oct. 21	....	....
1902	Mar. 27	Nov. 2	June 3	Sept. 29
1903	Mar. 3	Oct. 31	May 23	Sept. 10
1904	Apr. 8	Nov. 5	May 29	Oct. 3
Average	Apr. 1	Oct. 26	May 29	Sept. 24

Normal monthly and annual temperature and precipitation.

Month.	Grand Junction.		Collbran.	Month.	Grand Junction.		Collbran.
	Temperature.	Precipitation.	Precipitation.		Temperature.	Precipitation.	Precipitation.
	°*F.*	*Inches.*	*Inches.*		°*F.*	*Inches.*	*Inches.*
January	27.0	0.61	0.98	August	75.6	1.15	1.31
February	31.3	.59	1.44	September	67.2	.93	1.02
March	42.8	.83	1.68	October	52.8	1.16	1.06
April	53.2	.66	1.29	November	40.1	.63	.94
May	61.6	.63	1.12	December	27.8	.41	1.18
June	71.8	.35	.65	Year	52.4	8.50	13.78
July	77.8	.55	1.11				

PHYSIOGRAPHY AND GEOLOGY.

Grand Valley has been carved out of a high plateau region of sedimentary rocks. The valley proper is considered as comprising all the lands north of the river that lie below the more or less well-defined mesa, along which flows the upper lateral of Grand Valley Canal, and a few very small areas occurring in bends south of the river. For the most part the river on its south side skirts a steep bluff which rises to a height of from 150 to 200 feet. The valley to the north of the river, between the river and the mesa on the north, is marked by several more or less well-defined bluffs, which in places are 25 to 50 feet in height. The most notable of these form the northern boundary of the large area of Laurel sandy loam just west of Grand Junction. The surface of the valley in some places has a grade of fully 100 feet to the mile. As a rule, however, the surface is nearly level, requiring no great amount of labor to prepare it for irrigation. North of the valley proper much of the Mesa fine sandy loam has a smooth surface, while other areas are very rough and broken, often to such an extent that irrigation would be very difficult.

Grand River enters the area in the extreme eastern end of the sheet and skirting the south side of the valley flows in a direction a little south of west to its confluence with the Gunnison River at the town of Grand Junction. Here it turns in a nearly northwesterly direction, which general course it keeps to the western limits of the survey.

East of the Gunnison and south of the Grand River, in sections 28, 29, and 30, T. 1 S., R. 1 W., and in sec. 25, T. 1 S., R. 2 W., there is some comparatively level land. The remainder of Orchard Mesa—that part of the bench lands south of Grand River and east of Gunnison River—is rolling, and in some instances rough, so much so as to be difficult to prepare for irrigation. West of the Gunnison River, on the south side of the Grand River, is a small area of bottom land and quite a large area of rolling bench lands that could be irrigated if water were supplied.

As has been before stated, the whole region is one of sedimentary rocks. Near Palisades, on the northern side of the area, the bluffs rise almost perpendicularly for nearly 1,000 feet. The capping is of a reddish sandstone, with the underlying material a blue carboniferous shale. Coal measures are found throughout this shale, and a number of mines are now worked. About 5 miles west of Palisades this bluff bends and extends to the northwest. Due north from Grand Junction the bluffs are 12 miles distant and are known as Bookcliffe Range. The mesas on each side of the river are the remnants of an old flood plain and are composed of material deposited by the river at some earlier time. In a few instances this flood plain is so eroded as to form hills of the sandy loam soil. Shaly areas exist wherever the sandstone or this overlying capping of alluvium has been worn completely away, and shale also underlies all the mesa soil to the south of the river. Just across the river from Grand Junction a coal mine has been opened that supplies a fair grade of soft coal.

SOILS.

The soils of Grand Valley are made up almost wholly of material derived from sedimentary rock formations, the only exception being those soils that have been deposited from the waters of Grand River, which reaches back into granitic and volcanic regions to the east. A wide range occurs from the alluvial soils that are now being deposited by the river, or directly traceable to it, to the strictly residual soils along the foothills.

The following table gives the name and extent of each type of soil found in the area:

Areas of different soils.

Soil.	Acres.	Per cent.
Mesa fine sandy loam	34,432	32.1
Billings fine sandy loam	26,944	25.1
Mesa clay	22,464	20.9
Billings silt loam	5,632	5.3
Fruita fine sandy loam	3,968	3.7
Billings clay loam	3,328	3.1
Laurel sandy loam	3,072	3.0
Laurel fine sand	3,008	2.9
Mesa clay loam	2,240	2.0
Billings clay	1,664	1.5
Fruita loam	512	.4
Total	107,264	....

LAUREL FINE SAND.

The Laurel fine sand is a loose, reddish-brown, friable, easily cultivated sand of medium to fine texture, ranging in depth from 1 to 6 feet. The subsoil consists of rounded and worn river gravel. Often this gravel is mixed with the soil, thus forming a very gravelly phase of the type.

Immediately along Grand River from Palisades to the western extremity of the area the Laurel fine sand occupies long, narrow strips of the low bottoms and is often subject to erosion in time of high water. Except for small channels and abandoned stream beds existing as sloughs or bayous, the surface is comparatively level, and this land may be placed under irrigation with little labor.

The loose, open, porous nature of the soil insures the ready penetration and leaching of water, and if the type were not so low lying it would have excellent drainage. A part of this type, however, suffers from seepage from the higher areas.

The Laurel fine sand is an alluvial soil of comparatively recent deposition. It is difficult to detect the presence of even small quantities of silt or clay in the sediments, the soil being made up almost

wholly of particles larger than 0.
river has shifted it has deposited
from granitic and volcanic regio
and partly from the weathering
gravel shows excellent specimens
as rounded fragments of sandstone

Small areas of this soil show a b
organic matter, but the major pa
and requires fertilization with son
crops. Areas affected by seepag
salts at the surface, but such ac
and should be greatly lessened by

The principal crops grown are
the earlier settlers planted fruit t
now injured by seepage, though
well.

The Laurel fine sand is best ada
of these are usually secured.

The following table gives the r
sample of the fine earth of the soil

Mechanical analysi

Number.	Description.	Fine gravel.	Coarse sand.
		Per cent.	*Per cen*
13427	Soil	0.0	1.

LAUREL S

The Laurel sandy loam is a bro
loam, 2 to 6 feet deep, underlain
occurs it is in turn underlain by g
feet from the surface. The unde
color, and general nature as the
similar to the river gravel now four
patches and ridges the gravel re
patches of a gravelly phase of the
ing the position of old stream b
nature and should be classified as

Old stream beds and sloughs
uneven, but are not a serious diffi
for irrigation.

The soil is leachy and allows t
because of its low-lying position,
6 to 20 feet high, much of it now s
upon the higher levels.

The Laurel sandy loam has all been deposited from the waters of the river as it has shifted its bed, and like the Laurel fine sand is composed of a mixture of particles coming from the disintegration of sandstone, granite, and volcanic rocks. The soil is fairly productive and contains considerable organic matter derived from the decay of vegetation which covered the soil prior to cultivation.

Wherever seepage water has neared the surface or the soil has become water-logged alkali is rapidly accumulating, and much of the type in such areas is even now so badly impregnated that crops are injured and in some instances cultivation wholly precluded. The most notable area thus ruined lies just west of the town of Grand Junction, where a tract of about 200 acres, once highly productive, has been practically abandoned, much of it being in the condition of a swamp.

The Laurel sandy loam is peculiarly adapted to the growing of truck crops, and, where the water table is not too close to the surface, to fruit trees, either apple, peach, or pear. Berries and the smaller fruits are a marked success. Sugar beets yield well, and alfalfa, if the water table be below 4 feet, is a very successful crop. Truck crops and berries, however, are best suited to this soil, and, as they are more valuable than the other crops, should be grown wherever marketing facilities will permit.

The following table gives the results of a chemical analysis of this soil:

Mechanical analysis of Laurel sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13428	Soil	0.0	0.3	0.8	15.9	29.8	40.9	12.3

BILLINGS FINE SANDY LOAM.

The Billings fine sandy loam is a light-gray to brown fine sandy loam, 6 feet or more in depth. In some instances an imperfect stratification is discernible, showing alternate beds that vary in texture from a heavy fine sandy loam to almost a fine sand, but as a rule practically the same texture obtains to a depth of more than 6 feet. When moist the soil is friable and easily cultivated, but when dry tends to bake and if worked in such condition breaks up in large hard clods and is difficult to restore to good tilth.

Nearly all of this type of soil has a peculiar tendency to settle when irrigation water is applied, the total amount of settling often being 4 or more feet. Sometimes a season's thorough irrigation is sufficient to accomplish all the settling, but often the soil continues to settle for four or five years. The settling is not always uniform, but may occur

only in patches, so that muc
high places and filling in th
mate level. This settling
ture, as no relation can be
content or other obvious ch

The Billings fine sandy lo
Palisades to near Fruita, b
the soils deposited immedi
the surface is a broad, smoo
from about 10 to more than
mittent streams cross from
and in some instances wid
perpendicular banks, but a
Several waste ditches from
along land subdivisions to
quent checks and drops, th
feet deep, but they are quit
as they furnish drainage wa

The drainage features of
however, being more than
used it excessively, so that
suffering from seepage.

The Billings fine sandy lo
material derived from the
northern part of the area,
has been deposited through
the north and flow across th

The shale hills to the nor
rial has been derived partl
that alkali will be found in
of it contains alkali in va
generally well-drained cond
being almost wholly washed
alkali areas, as shown upon
soil seems, in general, to be
required but little fertilizati

Because of its deep, unifo
loam is preeminently adapt
and sugar beets. Upon it a
great Palisades peach belt.
excellent condition. It is
trees in order that they ma
acres are producing excell
three crops each year, whi

Potatoes and other truck crops, grain, corn, and berries do well. Sugar beets are a paying crop, yielding from 10 to 15 tons per acre.

The following table gives the results of a mechanical analysis of a typical sample of this type of soil:

Mechanical analysis of Billings fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13437	Soil	0.1	0.6	0.8	11.0	40.0	32.1	15.7

BILLINGS CLAY LOAM.

The Billings clay loam is a light-gray to dark-brown, sticky, plastic, compact loam, hard when dry, and difficult to cultivate. It varies from 4 to 6 feet or more in depth, and in the shallower depths is underlain by clay or clay loam of slightly darker color. The soil in general appearance is similar to the Billings fine sandy loam, but on closer examination it is seen to be heavier, the clay content being quite marked. It occupies an intermediate position between the Billings fine sandy loam and Billings silt loam or clay and occurs only in a few areas in the valley. The surface is generally smooth and level and needs but little preparation for irrigation. Except for a few gullies and some surface irregularities along the lower edges where there may be a slight drop to the river soils, the surface is naturally in good condition to receive water. A part of this type has begun to be damaged by seepage waters from higher levels, and such areas are now receiving an accumulation of alkali. The type, as a whole, however, lies at such an elevation that artificial drainage may be installed to carry off the surplus seepage.

Like the Billings fine sandy loam, the Billings clay loam is derived from the shale, sandstone, and mesa soils to the north, and is simply a finer deposit than the sandy loam laid down at lower levels. From indications in uncultivated areas, nearly the whole of the loam in the virgin state carried alkali in harmful quantities. This alkali, however, practically disappeared under culivation, and the soil was free until seepage water began to collect. The seepage areas are now affected with alkali and are constantly becoming more so as evaporation from the surface takes place.

Alfalfa, apples, pears, corn, and the grains are the principal crops grown. Apples and pears do well in the well-drained areas. Alfalfa is a decided success, yielding from 4 to 6 tons per acre in three cuttings. Wheat and oats give fair yields. Sugar beets are not extensively grown on this soil, but should prove to be very profitable. The Billings clay loam may be said to be well adapted to apples, pears, wheat, oats, corn, alfalfa, and sugar beets.

The following table shows the re
typical sample of the soil of this ty

Mechanical analysis c

Number.	Description.	Fine gravel.	Coarse sand.
		Per cent.	*Per cent.*
13432............	Soil.........	0.1	0.3

BILLINGS S

The Billings silt loam is a heavy,
gray to dark-brown color, from 3
clay loam, or clay. The soil becon
and if cultivated in that condition
weather into small cubes somewh
In fact, the soil is locally known a
characteristics. When moist, the
wet to saturation becomes very s
enced in cultivation to secure scouri
of a darker color, contains more cla
surface soil.

The Billings silt loam usually oc
lower levels above the river soil
Grand Junction an area extends ne
north of the valley.

The surface of the type is usuall
except for gullies and breaks alo
Little labor is required to level for
upon any other soil of the valley,
Billings clay.

Since it occupies the lower levels
colating waters, much of the type
seepage. Especially is this true in
school. Like the other soils of t
loam has been derived from the sh
the north of the valley. It closel
and can be best considered as suc
of waste deposited from small, int
silt loam now contains alkali in
that have never been cultivated ar
the irrigated ones. In all likeliho
this soil before irrigation began.

The Billings silt loam is not gener
but if care is exercised in growing
down, fair crops of apples and pea

well. Sugar beets are being grown in a small way and give good returns. Wheat and oats make fair yields. Sugar beets and alfalfa are the principal crops suited to the soil and should be grown wherever practicable. Well-established orchards should be greatly benefited by detailed drainage with tile or boards wherever water is less than 4 feet from the surface.

The following table gives the results of a mechanical analysis of a typical sample of this type of soil:

Mechanical analysis of Billings silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13434	Soil	0.0	0.2	0.2	2.9	15.1	59.7	21.9

BILLINGS CLAY.

The Billings clay is a very stiff, heavy, sticky, gray to dark-brown clay loam, 4 to 6 feet or more in depth. Shallower areas are underlain by a sandy loam of the same characteristics as the material forming the Laurel sandy loam. The soil is very difficult to till, bakes and breaks into cubes when dry, and withal is most refractory. It is located at the lowest levels formed by the washes from the north of the valley and is composed of the finest particles of sediment brought down by them. Only a few areas of this type occur in the area surveyed.

The surface is in the main quite smooth and level. A few gullies and washes are the only departures from a uniform grade and these do not interfere with irrigation in any way. Because of its low-lying position much of the Billings clay suffers from a high water table or from seepage. Such areas, however, are usually so high above the present bed of the river that drainage would not be difficult.

This soil, like the others of the Billings series, comes from the sedimentary formations that lie north of the valley proper.

All the seepage areas and some other parts of the type with a fairly low water table suffer from an accumulation of alkali. In the seepage areas this condition is getting worse, but other areas by judicious flooding may be farmed and are improving. Artificial drainage should be installed in the seepage areas as soon as possible, to prevent further damage.

Grain, sugar beets, and alfalfa are the only crops grown with success on the Billings clay.

The following table gives
typical sample of this type o

Mechanica

Number.	Description.	Fine gravel.
		Per cent.
13435	Soil	Tr.

MES

The Mesa fine sandy loa
friable, easily cultivated fine
depth, underlain by shale
mined depths. The shale su
exposed the salts crystalliz
leachy and requires much
wet, however, the heavier ar

In a few isolated areas a s
sand," exists at or near the
application of water and is
Mesa fine sandy loam is ve
interfere with cultivation or
renders the soil more leachy,
of water in irrigation. The
at some past time across the v
on both sides of the river, an
Much rounded gravel outcr
cles are often cemented toge

The topography of the typ
through slightly undulatin
Much of the land immediate
of Grand Junction, and the
west of Grand Junction, are
water can be supplied.

All of the Mesa fine sand
lying position will always be

The soil has been formed
streams, which brought the m
and volcanic regions. It h
by erosion and wind action.

Except for the underlyin
harmful quantities of alkali
tion should always remain s
and if orchards or other tille
plied by growing cover crops

Very little of the Mesa fine sandy loam is as yet under cultivation, but on Fruit Ridge and Orchard Mesa this type of soil supports some of the finest orchards in the valley. Alfalfa and truck crops are also a marked success. The soil is preeminently adapted to fruit and other tilled crops.

The following table gives the results of a mechanical analysis of a typical sample of this type of soil:

Mechanical analysis of Mesa fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13429............	Soil.........	0.4	1.3	3.1	18.3	21.1	31.1	24.5

MESA CLAY.

The Mesa clay is a sticky heavy clay loam or clay of a light grayish to dark slaty color, 1 to 6 feet or more in depth, underlain by shale. It is difficult to till and liable to bake, but when properly cultivated is rich and productive. It occupies a few small areas along the margin of hills in the eastern and central parts of the area and constitutes almost all the soil of the western part of the survey.

The topographic features of the Mesa clay range from slightly undulating and almost level plains to rough hills with almost perpendicular cliffs. Much of it is too rough for irrigation, but the large district in the west is well suited to irrigation farming and is very productive.

Throughout the Mesa clay spots have "gone to seep." This is so noticeable that many people in the valley stoutly aver that all the seepage land is due to shale in the subsoil. This seepage occurs in the shale lands principally where the underlying shale has forced the water near the surface. The topographic features of the type are such that it should be well drained, but when the water reaches the well-nigh impervious shale it follows it until it nears the surface, when the overlying soil often becomes swampy. In this way a hillside with steep slopes may become a marsh. This condition is more difficult to correct and presents a more complicated problem than the question of seepage in the areas where the damage is due wholly to a general rise of the water table. The subject will be more fully discussed under a separate heading.

The Mesa clay comes directly from the weathering of the underlying shale formation. In the deeper and more level areas the soil is partly colluvial, having received washings from surrounding areas of the same material.

The Mesa clay is principally devoted to beet culture. Some alfalfa and a little grain are grown, yielding fairly well. Tree fruits are not a success, except upon the deeper areas, and there only the hardier

apples and pears should be s
growing of sugar beets and is
conditions yield from 10 to 2
per acre from three cuttings.

The following table shows
typical sample of this type o

Mechanic

Number.	Description.	Fine gravel.
		Per cent.
13430	Soil	0.5

M

The Mesa clay loam is a stifl
difficult to cultivate and lia
deep, usually underlain by sa
underlain by shale or sandsto

The Mesa clay loam occurs
sandy loam, and is composed
loam washed into these depre
tically level surface, and requ
for irrigation. The type lies
River on what is known as C

All the Mesa clay loam is p
nary care, will remain so. I
adapted to the growing of alfa

The following table gives a

Mechanical c

Number.	Description.	Fine gravel.
		Per cent.
13131	Soil	0.6

FRUITA

The Fruita fine sandy loam
of medium to rather fine text
shows throughout imperfect s
almost pure sand alternating
It is friable and easily cultiva
In its virgin state there often
the soil particles are so cemen
These spots are due to the pr
but upon irrigation they mos

The Fruita fine sandy loam occurs principally in a large area surrounding the town of Fruita. The surface is quite smooth, requiring very little leveling to prepare for irrigation. Several large washes have cut this area of the type. One of these just northwest of Fruita for a part of its distance has a width of one-eighth of a mile and a depth of about 25 feet. In this wash water now flows at all times, being supplied by seepage from surrounding lands.

Nothwithstanding that water passes readily through this soil and that the gullies offer excellent outlets for drainage, much of the type now suffers greatly from seepage. East and northeast of Fruita is a great apple district, where nearly all the trees are affected. If these orchards are to be saved, drainage must be accomplished soon. The washes and gullies will furnish excellent outlets and should be so utilized.

The Fruita fine sandy loam has been formed almost wholly from débris from the sandstone to the north of the valley and from washings from the Mesa fine sandy loam. The two large washes that traverse it have brought the soil to the valley and deposited it in a great alluvial fan across the plain. In its virgin state the soil contains less alkali than those of the Billings series. Wherever seepage is injuring the orchards or other crops alkali is accumulating, and unless the water table be lowered and constant care exercised in cultivation alkali will increase in quantity over the entire seepage area.

The Fruita fine sandy loam is an excellent fruit soil. Some of the finest apple and pear orchards of the valley are upon this type. It is in fact a good soil for almost any of the crops suited to the climate of the valley. Wherever drainage is good alfalfa, grain, sugar beets, and garden crops all do well. On the seepage areas, however, only grains, garden crops, and sugar beets succeed. Alfalfa and fruit trees are injured by the high water table. On lands not too badly affected by seepage sugar beets yield 10 to 20 tons, alfalfa 4 to 5 tons, wheat 15 to 40 bushels, and oats 40 to 60 bushels per acre.

The following table gives the results of a mechanical analysis of a typical sample of this type of soil:

Mechanical analysis of Fruita fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13426............	Soil.........	Trace.	1.2	2.1	24.2	26.9	34.6	10.9

FRUITA LOAM.

The Fruita loam is a reddish-brown, sticky, compact loam, 1 to 3 feet deep, underlain by a sandy loam similar in texture to the Fruita fine sandy loam. When dry it is very hard, breaks up in huge clods,

and shows a tendency to assume
soils. If stirred when moist it is
exercised to prevent packing and

The type occupies the depressio
Fruita fine sandy loam, and is all
is the poorest drained soil of the
planted on this type have died, ar
alfalfa are grown. Artificial drai

This soil has the same origin a
merely the finer particles deposit
now begun to show on nearly all t
ment of the seepage condition this

If well drained the Fruita loam
present condition it is suitable o
beets and the grains.

The following table gives the av
of this type of soil:

Mechanical anal

Number.	Description.	Fine gravel.	Coarse sand.
		Per cent.	*Per cen*
13423, 13424	Soil	0.1	1.1
13425	Subsoil	Trace.	.1

HA

Strictly speaking, there is no
throughout the valley and occasi
formation is often encountered at
known as "cement sand" or "ce
caused by the presence of a sma
black alkali, which salt has a pec
It is very difficult to get these s
thoroughly wet they soon disappea
out by the irrigating water. The s
character that no attempt was mad

In parts of the Mesa clay the sh
there forms an almost impervious
sometimes referred to as a hard
from which the overlying soil has

On Orchard Mesa, south of th
gravel subsoil is sometimes cemen
pan, but these areas are small a
whole, the valley is practically free

ALKALI IN SOILS.

Alkali occurs in patches throughout the valley proper, and in the shale soils wherever found. The largest areas are in the vicinity of Grand Junction. Almost every tract of virgin soil in the valley proper shows quite marked accumulations, so that in all likelihood much of the valley now producing good crops carried an excess of salts before irrigation. A road or fence line is often the boundary between good lands producing crops and virgin lands having more than 1 per cent of alkali. Wherever the shale which underlies the sandstone formation is exposed alkali effloresces on the surface. The percentage carried by this rock is often not very high, but is quite sufficient to account for the alkali of the valley. All the soils that in their virgin state contain alkali have been formed in part or wholly from this shale.

On the seepage lands, where alkali is now accumulating, the salts come from the seepage water which has leached through the alkali-impregnated soils and subsoils of the valley. A small proportion of the alkali may come from the disintegration of the soil, but the major part comes originally from the salts of the shale.

The following table gives the composition of the alkali occurring in the soils:

Chemical analysis of alkali crusts.

Constituent.	No. 43. 2-40, S. 24, T. 1 S., R. 2 W.	No. 59. 7-40, S. 15, T. 1 S., R. 1 W.
Ions:	*Per cent.*	*Per cent.*
Calcium (Ca)	6.53	3.83
Magnesium (Mg)	3.04	3.71
Sodium (Na)	21.86	24.17
Potassium (K)	.92	.86
Sulphuric acid (SO_4)	11.01	45.04
Chloride (Cl)	35.55	21.99
Bicarbonic acid (HCO_3)	1.40	.40
Nitric acid (NO_3)	21.69	Trace.
Theoretical combinations:		
Calcium sulphate ($CaSO_4$)	15.60	13.02
Calcium chloride ($CaCl_2$)	5.36	....
Theoretical combinations—Continued.	*Per cent.*	*Per cent.*
Magnesium chloride ($MgCl_2$)	11.91	18.40
Sodium chloride (NaCl)	33.72	35.22
Potassium chloride (KCl)	1.74	1.50
Sodium bicarbonate ($NaHCO_3$)	1.92	.53
Sodium nitrate ($NaNO_3$)	29.75	....
Sodium sulphate (Na_2SO_4)	....	31.33
Soluble salts	12.2	28.5

The alkali in the soils prior to irrigation was pretty evenly distributed throughout the soil column, as is shown by borings upon areas of virgin soil north and east of Grand Junction. In the seepage areas upon lands which were once free from alkali the accumulation since irrigation is principally at or near the surface, rarely extending in quantity below 3 feet.

UNDERGROUND AND SEEPAGE WATERS.

Practically none of the underground waters of the valley are used either for drinking purposes or for irrigation. Cisterns supplied from the ditches or water hauled from the river furnish the supply for domestic use. Well water is all considered too salty for drinking purposes. In fact, practically no wells exist in the valley.

Perhaps no subject is at present so vital to the farmers of the valley as the seepage problem. Starting in the low places and along the slopes below canals, seepage areas have gradually spread until now many hundreds of acres are in a fair way to become valueless, unless radical changes are introduced in the methods of dealing with the evil. Among the farmers and real-estate dealers many and conflicting opinions as to the cause of the seepage are expressed and almost as many remedies suggested. It seems under the circumstances to be well to consider the causes under two heads, viz, seepage caused from lateral percolation from canals and seepage due to a general rise of the ground water from excessive irrigation.

For the greater part of its course the high lateral of the Grand Valley Canal follows along the edge of the mesa lands that bound the valley proper on the north. In many places it cuts across points of the mesa, and lands below have a steep slope for several hundred yards. Wherever the underlying material is impervious, as where the canal cuts the underlying shale or where the slope below is steep, the soil immediately below the canal or at the point of the outcropping of the shale is seepy. Throughout the area of Mesa clay this seepage from lateral percolation is marked, and numberless small areas testify to the gravity of the problem. Often the seepage occurs on steep slopes, and in no case can it be traced to a general rise of the ground water. The remedy that naturally suggests itself is to cut off the underground flow above the point of seepage. This is a very difficult thing to do, as the surface of the underlying impervious shale is very irregular and broken. Ditching to cut off the underflow can often be done only at a greater expense than can be borne by the affected lands. The only way to determine the feasibility of such ditching is by careful surveys and prospecting to ascertain the amount of ditching necessary to tap the underflow.

By far the greater part of the damage from seepage in the valley, however, comes from the general rise in the ground water. The water that causes the rise comes partly from seepage, but mainly from excessive irrigation. Practically all the damage in the large area affected east and north of Fruita has been caused by the use of excessive amounts of water. The soil allows the ready penetration of water, which after the subsoil is once filled must pass laterally through the soil until it reaches some outlet. Soils that would other-

wise be well drained are in thi
soon as seepage has filled the
evaporation from the surface h
begin, which tends further to ir
rate the two evils, but it is fai
cally ruins the land for all tree
some time, but eventually mu
seepage and its attendant accu
and the evil is spreading. If th
to irrigate the high-lying mesa
more serious than it is at prese

It is safe to say that there i
injured from a gradual rise of
gullies cut through the valley
affected lands to insure good ou
ficient intervals to lower the
would not be prohibitory in co
such drains are installed care
evaporation from the surface, b
in a productive state. Wherev
should be made to wash into
accumulated at the surface.

WATER SUPP

The supply of water for irri
Grand River. A small area on
of its junction with the Gunnis
plant from the latter. It is pla
lands west of this point with w
remainder of the valley draws
supply greatly exceeds the pres
be greater than can be used by
is rarely, even in the lowest peri
the head gate of the Grand Vall
consequence now diverting w
Grand Valley Canal, at the extr
headworks of two pump ditches
respectively, for the Palisades a
ply water to about 10,000 acres
is above the gravity canal.

South of the river two pump
on Orchard Mesa. These pum
run by water power, which is no
Mesa are private ones. Palisad
75 cents per acre. The origin

which the district was bonded, the interest on bonds being an additional levy. Near where the Gunnison flows into the Grand River there is a pumping plant that takes water from the former stream to supply lands south of the Grand River and west of Gunnison. Along the river there are a number of water wheels that raise water for small tracts, and across the Grand River almost south of Fruita is a small ditch that irrigates a few farms on river-bottom lands.

Water stocks and rates are remarkably cheap under the present only large ditch of the valley. Water stocks sell for $25 per inch, an inch being used for 2 acres. Considering the cost in other districts of the West this is remarkably low.

Quite a number of plans to irrigate lands on Orchard Mesa have been brought forth, and from time to time parts of ditches have been constructed, but all these have now been abandoned except the two ditches above mentioned.

All irrigation in the valley, either proposed or now operative, means the use of the waters of the Grand or the Gunnison River, which contain no deleterious salts or other substances in quantities that will ever be injurious.

AGRICULTURAL METHODS.

Practically the same methods are pursued in the growing of all the various tree fruits of the valley. The first step is to sow the land to grain or other annual crop for one or two seasons, during which time it is heavily irrigated to induce rapid settling. Peaches are most extensively planted, principally the Elberta variety. The trees are set at different distances, varying from rows 16 feet apart with 12-foot intervals between trees in the row to 24 feet apart each way. Experience has demonstrated that in this valley the peach tree is long lived and may grow to be a very large tree and yet preserve its full vitality. The most noticeable thing in the older orchards is the crowding that is taking place. Ten-year-old trees should be not less than 25 feet apart, and in many cases would do better if they were 30 feet apart. After the young trees are set out they are irrigated each summer from May to September, inclusive. No winter irrigation is practiced. A few fruit growers plant truck crops, corn, or potatoes in the spaces between young trees. Others cultivate only a small strip along the row and leave the middles to grow up to weeds. The majority, however, cultivate the entire surface of the field, which is left fallow and irrigated in three or four furrows between each row of trees. If the irrigation is extended to three or four furrows so as to wet the entire soil, the method of cultivating the entire space and growing no crops is no doubt the best. However, if fertilized, there seems no reason why truck crops should not be grown in the spaces between the trees, as this method insures thorough wetting of the ground and also

affords substantial returns d
orchard. When the trees com
crops for fertilization should
should be from not less than th
and preferably from four or fiv
only one small furrow on each
practice tends to induce bunch
not draw from the entire area a
orchards is by the furrow meth
vation and the rainfall of the v
is no doubt the best way to appl

The apple, pear, prune, cher
cultivated in much the same
pear trees are set a little closer,
apples are set farther apart.
of the valley might be made, ho
trees are set. Almost every orc
the Fruita fine sandy loam som
from alkali due to seepage wo
flooding. This should be done
to lessen the liability of the so
place as soon as possible after
year or every six months shou
and greatly prolong the life of th

Practically no fertilization ha
from barnyard manure and c
fruit exchange at Grand Junctio
fertilizer, which was distributed
as an experiment than to supply

Alfalfa is sown either with or
trary to the usual rule in irrigat
partially furrow irrigated. Sm
called, are made across the fiel
about 2 to 4 feet apart. The
into these small furrows and th
percolation. For some of the
bake, this method is a good one,
taining much alkali flooding in
through the fields can not fail
being a nuisance at harvest time
to concentrate the alkali in the
many cases the only place wher
where the alkali has been washed
growing the greatest room for im
flooding for the method of "crea

Alfalfa is usually allowed to stand until blooming is about over before being cut. This makes the hay very woody and stiff and much less nutritious than when cut in the early bloom stage.

Wheat, oats, and other grains are cut by self-binders and thrashed either from the shock or stacked to await the coming of the thrasher.

Sugar beets are sown with beet drills in early May. Usually it is necessary to irrigate to bring the seed up. Furrows are made in alternate spaces between the rows through which water is allowed to flow. Two rows are thus irrigated from one furrow. After coming up the beets are usually hoed twice, cultivated twice, and irrigated with sufficient frequency to insure favorable moisture conditions. Upon maturity the beets are plowed out, topped, and hauled to the nearest railway station, where the beet-sugar company of Grand Junction receives them.

Truck crops, small fruits, berries, corn, and potatoes are grown in many small fields throughout the valley. The methods employed in cultivating these crops vary with almost every individual grower. The majority, however, are successful, and the valley, as a whole, has a growing business along these lines.

AGRICULTURAL CONDITIONS.

The farming classes of the Grand Valley are, as a rule, in a remarkably prosperous condition. A mortgage foreclosure is an almost unheard-of thing. The peach growers near Palisades have had an unbroken series of good crops that have brought them from $100 to $500 per acre net. These lands have advanced in value by leaps and bounds until now there is hardly any land in what is popularly known as "the peach belt" that can be bought for less than $500 an acre. The apple growers are only slightly less prosperous than the peach growers.

Alfalfa and grain growers are prosperous and secure good prices for their products. Alfalfa produces from 4 to 6 tons of hay per acre, and brings from $7 to $10 a ton. Vegetables and small fruits find a ready sale, and those engaged in the production of such crops are succeeding. The sugar-beet industry has been a boon to those owning land not suited to fruit or truck, and the growers of this crop are also prospering.

The farms are nearly all owned by the men who work them. No considerable proprietary holdings exist, except for three or four thousand acres owned by the beet-sugar company. Farms range in size from small 5-acre tracts, cultivated to fruit or truck, to 160 acres.

During the fruit picking and packing season much labor is hired. Women and girls of the valley do most of the packing, while the picking is done mostly by transient laborers who annually come to the valley during this season. Cultivation and irrigation are principally done by the farmers themselves, with occasional help of men

hired by the month. These
Middle Western States and a
selves to become landholders

The work required in the
grain and in the growing and
done by the farmers and the

The hand work in the bee
families who contract to do
$20 an acre. The team work

Grand Valley fruit is well k
peaches are of excellent quali
prices. The apples and pear
sale. A good quality of oat
beets have a high sugar cont
hay, because of the custom o
done, is of an inferior qualit
cutting. Vegetables and sma
quality.

The Laurel fine sand and
truck soils of the valley. Up
the peaches are grown, altho
prove an excellent soil for this
grown on Fruit Ridge in great
fine sandy loam. The Billings
ings clay are recognized as alf
Mesa clay is best adapted to s
valley are now grown upon this

The Rio Grande and Weste
into the valley. The Colorad
Denver and Rio Grande. The
Salt Lake City traverses the v
Junction a narrow-gauge bran
over the mountains to Ouray,
necting with the main line agai
from Grand Junction north t
about 12 miles, where are loca
plaint is heard about freight
there is no unfair discriminatio

The wagon roads of the val
be taken in the subject of g
should, however, put the road
their value to the county as a w

For many years the fruits of
in mining towns and less fav
however, the fruit association

have been shipping fruit to far-distant markets. Now the principal peach markets are Missouri River towns, and during the season of 1904 some peaches were shipped as far east as Boston with gratifying results. Apples are largely sold in the State, although many are shipped west, southern California furnishing an excellent market. Other fruits and vegetables are mostly sold to mining towns and cities within the State. The alfalfa is nearly all consumed in the valley. The fruit growers afford an excellent home market for this product. The sugar beets are all used by the local factory and bring a flat price of $5 a ton.

SOIL SURVEY OF THE G

By MACY H. LAPHA

LOCATION AND BO

The Gallatin Valley lies sligh
the State of Montana, and is ag
and productive valleys of the nc
area surveyed consists of about
Gallatin County, and covers pr
valley, together with a considera
grazing land of the upper valle
foothills. Upon the east and s
bases of the Bridger and Galla

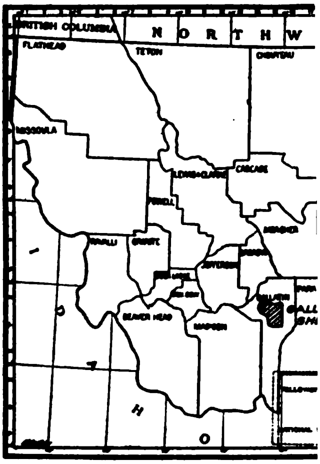


FIG. 42.—Sketch map showing locat

by foothill and mountain slopes
supplemented by irrigation fron
streams. The northern bounda
of hills or ridges, partially devot
dissected by numerous ravines
Valley from the valley of the up
The western boundary is forme
the limits of the irrigated lands
tivated ridges and elevated rolli
the Gallatin Valley from the val
miles farther west.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Comparatively little has been written concerning the history of the early exploration and settlement of this section. Authentic history of the region begins with the explorations of Lewis and Clark. The entire Gallatin Valley was traversed in 1806 by Captain Clark in returning from the expedition to the mouth of the Columbia River. At this time and until many years later the valley was overrun with treacherous Indian tribes. Although no tribes made their home here, the valley and pass had been for years the natural highway of bands of Blackfeet, Crows, Flatheads, Nez Percés, Snakes, and other tribes on their periodical hunting expeditions to the Yellowstone and Snake River valleys. For years the white fur traders made visits to this region in quest of beaver and other furs. With the waning of the fur trade came the gold seekers, piloted by such men as Bridger and Bozeman. With the advent of the gold diggers agriculture was taken up in a small way. Frequently those who failed to find the precious metal found wealth in the rich, virgin soil, their farm products commanding high prices at the mines. The town of Bozeman and other permanent agricultural settlements were established in the early sixties. Agriculture flourished, but for many years the valley lacked outside communication, except by slow and costly wagon trains. With the coming of the Northern Pacific Railway in 1884 a new era in agriculture, made secure through the aid of irrigation, was inaugurated. Following the early settlers, who had traveled from Missouri and adjacent districts along the trail of Lewis and Clark, came immigrants from the Eastern and Middle States and from foreign ports. Farms multiplied, towns sprang up, and important manufacturing and shipping points were established.

CLIMATE.

The average annual precipitation of the Gallatin Valley is between 16 and 17 inches, according to the records of the Weather Bureau station at Bozeman. Considerable of this is in the form of snow, there being usually from one to several months of sleighing at Bozeman during the winter. No data is available from other points in the valley, but the amount of precipitation in the lower part of the valley is believed to be slightly less than 16 inches, as the upper part of the valley, adjacent to the prominent mountain ranges, is subject to a heavier snowfall during the winter and a slightly greater precipitation from local thunderstorms and showers during the summer. The greater part of the annual rainfall comes during the late spring and the early summer months, the rains usually occurring as general storms with a gentle, steady precipitation. During the summer local

thunderstorms are of frequent oc
of the mountains, and are often a
dust storms, and hail. While som
to growing crops, they cover a re
insignificant proportion of the ye
violent cloud-bursts common in th
tically unknown in the Gallatin V

The average annual temperatu
shown by the monthly averages g
and frequently hot days occur dur
ever, are cool and pleasant, with
winter fair, clear weather accompa
occurrence, the thermometer some
—50° F. These cold waves altern
temperature. The extreme range
is unusually high, a difference of f
within twenty-four hours. Blizz
uncommon, occurring generally du
last killing frost in spring is looke
It sometimes occurs considerably
late as the latter part of June. T
erally occurs about the middle c

The average annual humidity is
temperatures of both the hot day
sometimes reached during the col
extremely variable in movement a
changes in both regards within s
general, a moderately brisk win
noticeable in the lower part of th
during the fall are generally swe
velocity. During the winter mont
winds are of frequent, but varia
sudden disappearance of the snow
able cloudiness occurs during peric
rains, and the winter months. A
of clear days is great. Fogs are
immediate vicinity of the larger s
ditions are such as to promote vig
able to crops.

The following table shows the mean annual temperature and precipitation at Bozeman:

Normal monthly and annual temperature and precipitation.

Month.	Agricultural College.[a]		Month.	Agricultural College.[a]	
	Temperature.	Precipitation.		Temperature.	Precipitation.
	° *F.*	*In.*		° *F.*	*In.*
January	23.3	0.80	August	63.4	0.63
February	22.4	1.11	September	52.1	1.51
March	29.0	1.16	October	46.0	1.04
April	40.6	1.91	November	31.1	1.27
May	51.1	2.74	December	26.9	.93
June	59.3	2.19			
July	63.2	1.31	Year	42.4	16.60

[a] Post-office, Bozeman.

PHYSIOGRAPHY AND GEOLOGY.

The Gallatin Valley, extending in a northwestern and southeastern direction, is about 25 miles long and has an average width of about 12 miles. The elevation ranges from about 5,600 feet at the southeastern extremity to about 4,200 feet at the northwestern end, the grade being steepest in the upper end of the valley. It is drained by the West Gallatin and East Gallatin rivers. These unite near the lower end of the valley and form the Gallatin River, which is a part of the headwaters of the Missouri. On the east the valley is bordered by the Bridger Mountains and on the south by the Gallatin Range. The former range of mountains is a most conspicuous feature of the landscape, presenting a bold valley border notched by canyons and natural passes. The range is formed mainly of stratified rocks and presents, when seen from the valley, a series of ledges, crags, and sharp pinnacles of light-colored rock, culminating in the smooth, rounded form of Bridger Peak and the more precipitous outline of Ross or Liberty Peak, these points reaching an elevation of about 9,000 feet.

The Gallatin Range, composed of volcanic material, is farther removed and less conspicuous, but its peaks are of sharp, precipitous outline, some of them reaching an elevation of more than 10,000 feet. The slopes of both these ranges are moderately well forested and favor precipitation and the conservation of winter snows until late in summer.

Upon the northwest there is a series of rough, greatly dissected hills, nearly barren of vegetation, composed of conglomerates, sandstone, quartzite, limestone, and shale. Extensive sloping terraces or fans, formed by the wash of material from canyon mouths, and plateaulike plains of ancient lake sediments form the remainder of the valley boundaries upon the northern and western sides.

The lands of the area survey
divisions—the valley bottoms
uplands, bench lands, or terrac
by the valley bottoms. These
extend across the area in the li
contracted at the lower or nortl
River cuts through the inclosin
to the two main branches of tl
of more or less regular flow tra
growth of cottonwood and wil
quently borders the stream ch
grasses of rank growth sometim

Under normal conditions th
discharging their maximum floo

In the vicinity of the lower va
poorly defined, the waters maki
series of interlacing, meanderin
lower-lying sections is freque
small, rounded pebbles and col
dance along the stream channel
beds occur.

The material covering the
rock fragments and fine alluvi
variety of rocks occurring in th
by running water from the surr
tain slopes. In the southeaster
colluvial material, derived fro
Range, has been commingled wi

The uplands or bench lands e
sloping terraces or fans to the
Range. The surface is generall
numerous ravines formed by mo
Alluvial fans occur in the vicini
cropping ledges of gneiss and
derived in part from glacial mo
seen along the margins of the
the canyons. Thickets of willo
ravine bottoms bordering the la

In the western part of the ar
unbroken body southward fro
area. Here the slopes are less
by intermittent stream chann
hilly as to be unfit for cultivatio
rated from the river bottoms by
Gravel and cobblestones occur
surfaces and in the vicinity of

forming these upland benches or elevated parts of the valley consists principally of alluvial material laid down in the waters of an ancient lake at one time occupying the entire valley, modified and augmented by great quantities of pumiceous volcanic dust ejected from distant craters and by alluvial wash of recent date.

SOILS.

In general the soils of the Gallatin Valley are fine-textured, heavy alluvial or silty loams. They are frequently marked by extensive accumulations of cobblestones and gravel occurring either upon the surface or as underlying deposits. Many of the soil types are quite similar in color, texture, and structure and merge or blend one into the other by imperceptible gradations. In such cases the boundaries separating the soil types are more or less arbitrary and unsatisfactory. Nearly all the types are subject to considerable local variation in depth, color, and structure, such variations usually occurring as small and relatively insignificant spots, but in the aggregate often covering a considerable extent of territory.

The following table shows the total area and relative extent of each type mapped:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Bozeman silt loam	76,608	36.8	Gallatin fine sandy loam	6,464	3.1
Yakima silt loam	53,824	25.9	Bridger clay loam	1,472	.7
Gallatin gravelly loam	32,576	15.7	Gallatin clay loam	896	.4
Gallatin silt loam	23,808	11.4			
Bridger gravelly loam	12,544	6.0	Total	208,192	

GALLATIN GRAVELLY LOAM.

The Gallatin gravelly loam consists of a compact, moderately heavy and sticky loam, dark-gray or brown in color, ranging in depth from a few inches to 3 feet. An appreciable amount of sharp particles of medium to coarse sand usually occurs throughout the soil section. Well-rounded pebbles and cobblestones are frequently thickly scattered over the soil surface, the larger fragments having to be removed to permit successful cultivation. The soil is underlain by a light-gray, sticky, silty loam, containing many flattened or well-worn pebbles or by great beds of cobblestones and pebbles mixed with river sands and extending to great depths. Frequently these beds occur within a few inches of the surface, the soil constituting merely a thin, superficial covering.

The Gallatin gravelly loam occurs most prominently as a single large body extending from the upper courses of Middle Creek and the West Gallatin River northward nearly to the valley trough, about 2 miles north of the town of Belgrade. Other small irregular-shaped bodies occur in the vicir ing into the loams of the valle nearly level or slightly sloping a streams, where it is occasional or minor terraces. A heavy g monly found in the river botto streams. Except in the immec however, the soil is generally de

Owing to the presence of und well drained and often requires water in order to insure profitab

The material from which th probably owes its origin and n degradation and the distributio rials gathered from the extensi beds, augmented by finer alluvia or from the rocks of the hills ar

This soil is free from injuriou to the restricted depth of the pr in plant foods. Under sufficient to rotation of crops and with manures, the soil where not too s to the growing of grain, hay, or r ing well-drained soils. Wheat, clover and alfalfa are the princi or even heavy under favorable c

The average mechanical comp is shown in the following table:

Mechanical analyses oj

Number.	Description.	Fine gravel.	Coar san
		Per cent.	*Per ce*
13808, 13809......	Soil.........	3.5	(

GALLATIN FI

The Gallatin fine sandy loam i depth, texture, structure, and ir sists typically of from 18 to 30 i medium to fine texture, the coa character. It is slightly stick assumes a loose, friable texture. will be described later. The so subsoil, frequently containing a l and pebbles. The subsoil ofter gravel and sand, and sometimes the soil is underlain directly by this latter material.

The Gallatin fine sandy loam occurs only in the vicinity of the town of Manhattan, in the extreme northwestern part of the area, and extends downward with a moderate slope from the vicinity of the bluffs marking the upper slopes and bench lands to the Gallatin and West Gallatin River bottoms, from which it is separated by a prominent bluff or terrace. The surface is devoid of tree growth and is generally smooth in outline, except in the vicinity of the bluff lines and streams, where the plain is somewhat dissected by small ravines and gullies. Gravel consisting of well-rounded pebbles is of frequent occurrence upon the surface, and outcrops of the underlying rocks occur upon the bluff line bordering the Gallatin River bottoms in the extreme northwestern part of the area of this soil.

Owing to its position and texture and the nature of the underlying material, this soil is well drained and requires generous applications of water under irrigation.

The material forming this soil is probably derived from a variety of sources, consisting of stream-borne sands and fine sediments gathered from adjacent mountain ranges, mixed with material derived by degradation of the Bozeman lake beds. The soil is deficient in organic matter and is improved by the addition of green or stable manures. It is free from injurious alkali salts. The Gallatin fine sandy loam is generally not adapted to the growing of dry-farmed crops. Under rather copious irrigation it is fairly well adapted to the growing of alfalfa, clover, forage crops, grain, and fruits requiring a light and well-drained soil and adapted to the existing climatic conditions. A considerable portion of this soil type is devoted to grazing. Upon the remainder a fair to heavy yield of barley, oats, and leguminous crops is produced under irrigation.

There is a sandy phase of the Gallatin fine sandy loam covering the eastern-central part of the main soil body. Here the soil is of a looser and slightly coarser texture, resembling under cultivation a sand of medium fine texture. It is of a more leachy character than the typical soil and somewhat less productive. In depth, character of subsoil, physiography, and other features it follows the preceding description.

The results of mechanical analyses of this soil type appear in the following table:

Mechanical analyses of Gallatin fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13806	Soil	0.6	4.8	7.7	23.1	30.1	24.8	7.9
13807	Subsoil	2.9	13.9	14.6	32.8	18.9	9.6	7.1

In extent of area covered an
silt loam is probably the most
ley area. Like the other soils
ation in texture and structure,
to 3 feet of light-buff or brow
what compact structure. It
a slight tendency to puddle,
friable and easily cultivated.
thick frequently occurs immed
ever, readily broken up by th
sticky, silty loam of light-buff
loam of very fine ashy textu
Gravel usually occurs only in t
upon eroded surfaces of marke

The Yakima silt loam occu
great uniform soil body lying
Other less extensive areas o
throughout the south-central
vicinity of the southern, easter
type covers the higher elevat
tion it usually occurs as elon
mounds or ridges. The southe
plateaulike ridges or plains, f
and terraces, rounded hills, a
body, lying to the south of M
ravines, gullies, and stream c
elevation erosion has been ca
considerable proportion of the

Owing to the elevated positi
age of this soil is generally ampl
seepage from irrigation canals
often extremely gravelly terrac

The Yakima silt loam owes i
ancient lakes of vast quantities
siderable amount of finely-divi
rial has since been reworked an
Considerable fine alluvial ma
districts to that originally de
erally productive, the soil is
and is benefited by green m
crops with alfalfa and clover.
frequently occurs in the subsoi
alkali salts. Owing to the nat

in most cases readily removed from the soils and do not occur in injurious quantities within the zone of root development, and it is unlikely that material damage from alkali will ever result upon this soil type.

The Yakima silt loam is well adapted to the growing of grain, with or without the aid of irrigation, and when irrigated is adapted to alfalfa, clover, forage crops, sugar beets, and other root crops, and probably to hardy fruits. Wheat, oats, and barley are the principal crops grown. Under irrigation and with good management the yields are generally high. Alfalfa is also grown to a considerable extent and gives good returns. In favorable seasons excellent crops of grain are produced without irrigation.

The average results of mechanical analyses of this soil type follow:

Mechanical analyses of Yakima silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13810, 13813......	Soil..........	0.1	0.4	0.4	2.3	22.8	65.9	8.0
13811, 13814......	Subsoil.....	.2	.4	.3	1.8	20.8	66.3	9.5
13812	Subsoil.....	Tr.	.2	.3	1.4	13.2	69.4	15.0

BOZEMAN SILT LOAM.

The Bozeman silt loam consists of about 1 foot of brown to nearly black, heavy, sticky, silty loam of compact structure, but usually moderately friable when cultivated in proper condition. Some variation, both in texture and structure of soil and subsoil, frequently appears. The soil often shows a marked tendency to puddle under unfavorable drainage or cultural conditions, and small local puddled spots often appear in which the structure of the soil is very dense. These spots, locally known as "buffalo wallows" or as "gumbo land," are difficult to till and are generally unproductive. Rather coarse, well-rounded gravel and cobblestones frequently occur in both soil and subsoil. The subsoil to the depth of about 3 feet consists of a dark-brown, tenacious, heavy silty loam or silty clay loam of compact adobelike structure. This in turn is usually underlain by river gravel, or by a light-yellow or light-gray silty loam of fine ashy texture, extending to the depth of 6 feet or more.

The Bozeman silt loam is of wide distribution in the Gallatin Valley area. It occurs as numerous irregular-shaped areas which are most prominent and extensive throughout the central, eastern, and northern parts of the area surveyed. Along the northeastern margin of the area a large body of this soil covers a great portion of the foot slope extending to the base of the Bridger Mountains. This slope is much dissected by many ravines and the channels of intermittent streams.

The surface is generally gravell
vicinity of larger streams, and i
all the other soil bodies of this t
and depressions, frequently in t
are unmarked by relief or promi

Natural drainage in some pa
type is frequently deficient. H
natural basins for the collection
the higher slopes, and consider
damaged in this way.

The material forming the soil
reworking of the finer sediment
addition of large quantities of m
adjacent mountains and valley
tains large quantities of lime.
quently present in small amou
deficient drainage, particularly i
the northern part of the area, t
within the zone of root develop
reduce or even to prohibit the pr

When well drained and free f
the growing of grain, alfalfa, clov
lower lying lands are better ada
clover. Under favorable cond
grain, clover, and timothy yield
lent quality.

The average mechanical comp
subsoil of this type is shown in t

Mechanical analy

Number.	Description.	Fine gravel.	Coa san
		Per cent.	*Per c*
13800	Soil	0.2	
13801	Subsoil	.4	
13802	do	Trace.	

GALLATI

The Gallatin silt loam consists
colored heavy sticky loam of fine
quently gravelly. The soil is no
times assuming an adobelike ch
under cultivation. In low, po
assumes the properties of muck
brown, blue-black, or light-colo
silty texture, usually extending

underlying material is subject to much variation, sometimes resembling the light-gray, silty textured material normally underlying the Yakima silt loam and the Bozeman silt loam and sometimes being greatly restricted in depth or entirely displaced by the occurrence of gravel sheets. The main bodies of this soil type occur in the eastern and north-central parts of the area, in the vicinity of Bozeman Creek and the East Gallatin River, the most extensive area lying adjacent to the latter stream and in the district lying north of and between the towns of Belgrade and Manhattan. Other smaller bodies occur near the east-central part of the area.

The Gallatin silt loam occupies the lower valley depressions and river bottoms. The surface is nearly level and is frequently marked by meandering stream channels bordered by a heavy growth of willows and other shrubs and trees. A large portion of this soil type, occurring in local depressions and along the lower valley trough, is poorly drained, is marked by a growth of semiaquatic vegetation, and in its present condition is unfit for the production of ordinary farm crops.

The soil-forming material is a heavy alluvium, derived by complete weathering of the rocks of the adjacent ranges and by degradation of former alluvial deposits. This has been deposited in the form of finely divided sediments from stream waters and has been modified by chemical changes and the decomposition and incorporation of vegetable matter. The soil contains a large proportion of this well-decomposed organic matter. Alkali salts in injurious amounts sometimes occur in local districts of deficient drainage.

When well drained and properly cultivated the Gallatin silt loam is well adapted to the growing of clover, timothy, grain, forage and root crops, potatoes, and hardy vegetables. In its present condition a large proportion of this type is devoted to pasturage in connection with dairying. Some quite extensive sections produce large quantities of timothy, clover, and wild hay, while grain is profitably grown upon the better drained areas.

The results of mechanical analyses of this soil type are shown in the following table:

Mechanical analyses of Gallatin silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13803	Soil	0.1	1.5	3.4	8.1	17.3	59.1	9.9
13804	Subsoil	.4	1.1	1.2	5.5	16.3	62.1	13.3
13805	do	1.1	1.4	1.8	12.0	26.3	40.9	16.5

GALLATIN CLAY LOAM.

The Gallatin clay loam is one of the least important soil types of the Gallatin Valley. It consists of about 3 feet of dark chocolate-brown, heavy, sticky, clay loam of compact adobelike structure, checking

upon exposed surfaces, and fre
angular rock fragments of the siz
underlain to the depth of 6 feet o
somewhat lighter color, or by be
are subject to considerable vari
adjoining types without distin
occurs as a few very small bodi
eastern and central sections of t
depressions of the valley floor or
of the valley trough. The natur
is frequently deficient. The soil
the heavy alluvial material gath
deposited from stagnant waters o
deposition from local intermitten
adjacent soil bodies. The Galla
organic matter. Small quantitie
the damage resulting from this s
When well drained, this type is
and hay, to which purpose it is
to heavy under favorable conditi

The following table gives the a
of the soil and subsoil of this typ

Mechanical analyses

Number.	Description.	Fine gravel.	Coars sand
		Per cent.	*Per ce*
13815	Soil	0.2	1
13816	Subsoil	.6	1

BRIDGER G

Like the preceding soil types, t
siderably in structure and textu
types without distinctive bound
of dark-brown to nearly black
texture, containing an apprecia
sharp particles of stone. Grave
occurrence in both soil and subs
subangular or angular chips and
while accumulations of cobblesto
The subsoil consists of a light-ye
fine and sometimes ashy texture
of the gravel of the overlying so

The most extensive and impo
loam occur as irregular-shaped

margin of the area surveyed. Other smaller and less important, irregular-shaped bodies occur near the southeastern and southern boundaries. The larger bodies of this type occur upon the prominent foot slopes of the Bridger Mountains. They usually occur next to the mountains or as alluvial fans or partially eroded areas at a greater distance from the base of the mountains, upon which the washing of material from the mountains by canyon streams has been most active. The areas of this type are intersected by bodies of the Bozeman silt loam, and the surface, while generally of quite smooth, uniformly sloping outline, is frequently cut by ravines and canyon streams. The smaller bodies lying along the southern and southwestern margins of the survey occur as small fans or foot slopes adjacent to the mountains or hills or cover portions of the rough, hilly ridges along the southwestern boundary of the area. Rock outcrops and masses of bowlders distributed by torrential mountain streams and the ice sheets of retreating glaciers occasionally occur on this type in the vicinity of the canyon mouths of the Bridger Range.

Owing to the elevated position, pronounced slope, and general character of soil and subsoil, the drainage of the Bridger gravelly loam is very good, and, where irrigated, considerable loss from run off and seepage frequently occurs. This soil is of colluvial origin, being derived from the weathering of rocks of the adjacent mountain slopes, washed down by heavy rains and intermittent mountain streams. This material is derived chiefly from the gneissic rock forming the lower slopes of the Bridger and the Gallatin ranges. In many of the areas of this soil type lying at some distance from the mountain slopes the overlying colluvial material is merely a thin covering deposited upon the fine sediments of the Bozeman lake beds.

The Bridger gravelly loam is devoid of alkali salts and is probably less rich in available organic and mineral plant foods than the finer alluvial soils of the bench lands and valley floor. Under efficient cultivation and with irrigation, it is generally adapted to the growing of grains, alfalfa, and hardy fruits. The less gravelly and more compact bodies of this soil are fairly well adapted to grain and hardy fruits, under careful methods of dry farming. Grain and, where capable of irrigation, alfalfa, are practically the only crops grown, the yields from the less porous and more compact bodies of the type being generally good in ordinary seasons.

The results of mechanical analyses of the fine earth of the soil and subsoil appear in the following table:

Mechanical analyses of Bridger gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13820	Soil	2.7	5.1	4.3	16.7	19.5	36.3	15.4
13821	Subsoil	2.6	4.7	4.9	19.0	20.7	32.2	15.9

BRID

The Bridger clay loam is a
consists of from 1 to 3 feet of l
taining considerable fine angu
pact, adobelike structure. It
or light-gray compact silty cla
and often containing a high per
soil is subject to much variatio
definite boundaries.

The Bridger clay loam occ
bodies along the southeastern,
the survey. It occupies slopin
tain slopes of the Gallatin Ran
ural drainage system is well de
ture and texture the soil is
retaining a large quantity of
supplying it to the crops in tin
of formation this soil is similar

Although somewhat heavy a
the soil becomes moderately fri
of grain without the aid of irr
irrigation. Grain is the princip
good to very good.

The results of mechanical an
subsoil of this type are shown i

Mechanical ana

Number.	Description.	Fine gravel.	Co
		Per cent.	*Per*
13817	Soil	0.4	
13818	Subsoil	.4	
13819	do	.8	

SOIL

The term "hardpan" as appl
pact, impervious structural co
agencies. Streaks, beds, and n
of common occurrence through
exert considerable influence up
duction. There is much vari
these sheets or beds of hardpan
agriculture only in small local
In the soils of the area surve
the surface a stratum of comp

thick. This material is sometimes partially cemented by lime or other substances, offers some resistance to plowing, and resists washing by rapidly flowing water for long periods of time. Rains percolate through it slowly, and where it occurs on slopes and hillsides some loss of irrigation water may be caused by the hastening of surface drainage or run-off. It is, however, not a true hardpan, and even, where occurring at the surface, is capable of cultivation when in proper moisture condition. Upon dry-farmed tracts it may be of no little benefit in retarding percolation of rains to the more porous subsoil, and thus conserving the soil moisture for the use of crops during periods of drought.

In the light-gray subsoils of ashy texture, frequently occurring in the area, local streaks or bands of white hardpan, caused by indurated layers of fine river silts, clays, and volcanic dust, more or less cemented by lime or other substances, are of common occurrence. These frequently exert an unfavorable influence upon the percolation and drainage of subsoil waters, or may, like the so-called hardpan described above, prove of benefit when occurring in the higher dry-farmed soils with more porous subsoils.

The term "gumbo" as used in the Gallatin Valley has a local meaning, and refers to a puddled, untillable structural condition of the soils rather than to any particular type of soil. This condition occurs usually as small local spots or sinks, frequently only a few yards in diameter, and sometimes marked by the presence of the puddled depressions common to the plains of the Northwest, known as "buffalo wallows." Small quantities of alkali salts often occur in these spots, and their unproductiveness is commonly attributed to this cause. Their presence is, however, due to the poor drainage and the compact structure of the soil, and the alkali salts are not usually present in sufficient quantities to render the soil unproductive.

The cause of this unfavorable condition of soil lies in the deficient drainage of these local spots, the trampling and puddling of the wet soils by animals, the outcropping of underlying impervious hardpan, or the cultivation of poorly drained bodies of heavy refractory soils when too wet. Artificial drainage and the application of large quantities of green or stable manure, straw, or other organic matter would probably improve the structural condition of such areas and render them productive.

WATER SUPPLY FOR IRRIGATION.

The principal source of irrigation water for the area is the West Gallatin River, from which the canals covering the main central and western parts of the area are taken. In addition, the waters of many creeks and small streams of more or less regular flow supply small,

independent irrigating systems c
natural or artificial channels. T
age area of 860 square miles, ha
or 718,260 acre-feet, during the
the U. S. Geological Survey gag
mum discharge of over 5,000 sec
of May and June.

The supply of water has usu
area under irrigation. During t
snowfall in the mountains, cou
irrigated area, has caused a mar
decreased crop production in cer
their water from the lower cours
is common, especially from thos
gravel beds of river bottoms.

The greater number of the sm
tained cooperatively by the patr
expense of maintenance. A few
ated by the West Gallatin Irriga
part of the area, supply water
average maximum cost of irriga
an acre.

Owing to the extension of the
tions of water supply through n
rights is becoming a somewha
probable that considerable litig
establish the status of the variou
tion of canals, headworks, flum
of water are urged, as by these
water could be made annually.

Since the irrigation water is d
application in large quantities
sugar beets or similar crops, ear
degree of chilling and tempor
respects the quality of the wate

UNDERGROUND A

The most prominent area of de
the vicinity of the East Gallatin
west of the town of Belgrade.
irregular-shaped area of about 10
trough and is locally known a
area to be cultivated after the se
a long time productive and valu

sion of irrigation the water table in this district has gradually approached the surface. In certain sections bordering this district irrigation is no longer necessary, as the soils are sufficiently wet by seepage or subirrigation arising through the application of large quantities of water upon higher lying lands, while upon extensive tracts within the district the land has become so water-logged that it is unfit for cultivation and large areas are now devoted only to grazing. In addition to this large district many smaller areas generally occupying former stream channels and extending in a north and south direction suffer from deficient drainage.

The accumulation of harmful quantities of soil water in these areas of deficient drainage is due to loss of water by seepage from canals or by run-off from slopes when irrigated. The remedy for this unfortunate condition consists in greater economy in the use of irrigation water, in preventing loss by seepage, and in thorough drainage of the subsoil. In the Gallatin Valley the conditions prevailing in much of the swampy lands and local areas of deficient drainage could be greatly improved by direct drainage, involving the cutting of a few open ditches or the laying of a few lines of tile. A more complete and thorough system of underdrainage would be necessary in the case of the lower lying areas in order to remove the fast accumulating subsoil waters. With the further extension of irrigation, conditions in these lower lying areas will become worse. If reclaimed, these tracts would form some of the most valuable and productive farming lands of the area surveyed.

ALKALI IN SOILS.

Only a relatively small proportion of the soils of the Gallatin Valley has been rendered unproductive by the presence of injurious amounts of alkali salts. In certain localities, however, considerable mischief has been wrought and the problem is becoming one of increasing importance. The main alkali areas occur in the vicinity of the valley trough, near the northern boundary of the survey. A small body of alkali land occurs a short distance south of Manhattan. A few other small spots or local areas occur in the central part of the area.

Of the alkali salts, sulphate of sodium is probably the most common in the Gallatin Valley. It is one of the least injurious of the common alkali salts, but is considered dangerous in concentrations greater than 0.20 per cent of the dry soil. Sodium bicarbonate is also of frequent occurrence in the soils and underground waters of the valley, while in certain districts the more highly injurious sodium carbonate or "black alkali" occurs in such quantities as either to reduce or prohibit the production of crops. The minimum limit of

concentration of this extremel
at 0.05 per cent.

The subsoils of the Gallatin
tities of injurious alkali salts,
injurious to ordinary crops.
excess irrigation waters mucl
and removed by the soil water
the influence of rapid evapora
trated and the salts accumula
or are deposited upon the surfa
eral methods have been propo
but thorough underdrainage i
cause of the trouble. After
flooding of the surface leaches
they are removed with the soil
ing of the land without floodin
in time allow of the removal of
In connection with drainage a
sible of some cultivated alkali-
quent cultivation of the soil su
to check evaporation and th
Sugar beets and sorghum are a
purpose. Sorghum might, ho
conditions in the Gallatin Valle
alkali soils is not recommended
alkali salts may greatly affect
content, but their value for fee

AGRICULT

The Gallatin Valley is not a d
profitable crops are limited by
attempt has been made to grow
The growing of grain is by fa
conditions of uniform productio
similarity in the agricultural m
backwardness in the adoption
certain sections of the valley, p
tled districts, the methods in v
soils, climate, and general eco
the crops produced, the farmin
have given rise to the widespre
the development of labor-savi
land for crops is generally acc
than is observed in many of the

Deep and thorough plowing and harrowing is of importance in forming a favorable seed bed and in allowing of a ready percolation of the soil by rains, and is of special value in the case of dry-farmed tracts. If followed by surface cultivation immediately after heavy rains or during periods of drought, when the character of the crop permits, the soil reaches the greatest efficiency in the collection and retention of moisture.

Summer fallowing is generally practiced on the dry-farmed tracts. In irrigated districts the rotation of grains with alfalfa and clover is a matter of common practice, resulting in increased yields and permanent benefit to the land.

Harvesting is accomplished by the self-binder, shocks are rarely capped or otherwise covered, and thrashing is frequently delayed until well into the late fall or winter months. Grain is seldom stacked in the field, but is hauled directly to the machine and thrashed. The machines are of the modern type, automatically feeding the grain and stacking the thrashed straw. When thrashed, the sacked grain is piled in the field until hauled to warehouses or elevators. Although frequently exposed to fall and winter rains and snows, but little damage is said to result from this apparent neglect.

Irrigation is generally accomplished by flooding, and both the canal construction and the methods employed in applying water to the land are frequently careless and wasteful. The use of more and better constructed flumes and pipe conduits in crossing ravines and gullies, while an item of greater initial expense, would materially shorten the canal lines and prevent the loss of much water by seepage. The use of more moderate quantities of water in irrigating crops and greater care in the preparation of lands by leveling and checking for irrigation are also to be recommended. The washing and cutting of the hill slopes by ditches and laterals with an excessive degree of fall is a frequent cause of irreparable injury and disfigurement and might easily be avoided.

AGRICULTURAL CONDITIONS.

In general, the farmers in the Gallatin Valley are prosperous and contented. The early temporary farm buildings were mostly constructed of logs, but now these first dwellings upon newly settled tracts generally consist of board cabins or modest cottages. The old log houses are still common, but in general these temporary structures have been replaced by more substantial frame buildings, frequently of neat and attractive appearance and bespeaking a condition of thrift upon the part of the inhabitants. Large, well-built barns and other farm structures are also common in the older and more thickly settled districts. The farming lands are usually well fenced and the condi-

tion of the live stock is gener
nity for improvement by the

The most of the farms are
renting of lands upon a cash
mon. The farms usually con
The average size farm for Ga
1900 was 388.1 acres. For t
size is undoubtedly much less
whites. The cost of labor is
reliable and efficient characte

The principal agricultural p
ley, and hay, the latter consis
hay. Alfalfa, upon the highe
upon the lower lands, are gro
irrigation. Timothy and wil
the lower depressions or valle
prices, either baled or in the
dantly and the quality of the p
is grown in the irrigated distri
35 to 45 bushels per acre, whi
said to be not uncommon. T
dry-farmed districts. The yi
tion, depending upon climatic
to 45 bushels per acre. Oats a
sively grown, producing heavy
siderable extent, especially in t
yielding 60 or 70 bushels per a
it being purchased at fancy p
malting purposes. Stock rais
importance and are capable c
could probably be produced p
able local demand for vegetab
ever, unsuited to the growth of
But little attention is paid to t
tation and control of the profit
here of greater weight.

The condition of the countr
is usually good. During the
early spring they frequently b
greatly improved. This condi
of narrow-tire farm wagons in h
ing the fall and winter season
line of the Northern Pacific R
service is capable of improveme
ucts are high and are generally

Bozeman, the county seat of Gallatin County, is the largest town and offers a local market, as well as shipping facilities, for farm and dairy products. Other important shipping points are Belgrade, Central Park, and Manhattan. Bozeman, Belgrade, and Manhattan are provided with mills and elevators of large capacity and are equipped with modern machinery for milling or shipping the great grain crops of the valley.

While the crops suited to the climatic conditions of the area are somewhat limited in number, the lands of this district are undoubtedly capable of producing a greater diversity of crops, including hardy fruits and sugar beets, and of supporting a much greater population.

SOIL SURVEY OF THE S

By MACY H. LAP

LOCATION AND BO

The Stockton area lies in th
Joaquin Valley, entirely within
the geographical center of the
tangular in shape and has an

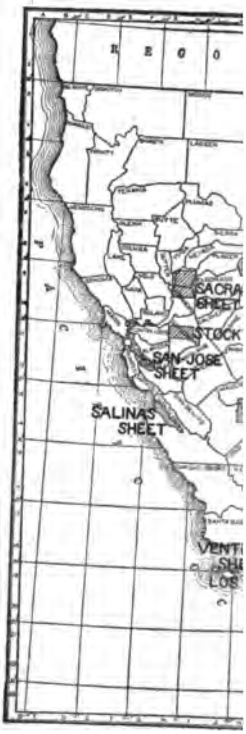


FIG. 43.—Sketch map showing loc

square miles. The city of Stockt
area.

The base map used in the soil s
field as the work progressed,
available.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

In the history of the discovery and early exploration of California the Jesuit priests and missionaries with their followers played important and romantic rôles. The scene of their struggles and sacrifices was, however, mainly confined to the coastal region. While the San Joaquin River owes its discovery in 1783 to the Jesuit missionary, Father Crispi, the exploration and the settlement of the district covered by this report fell to Americans and French Canadians at a later date.

The first of these to visit the San Joaquin Valley were hunters and trappers, some of them in the service of the historic Hudson Bay Company. At that time wild game, consisting of bear, deer, elk, and antelope, wild horses (escaped from the early Spanish adventurers and mission padres during their pilgrimages along the coast), and many smaller fur-bearing animals were abundant. These nomadic trappers explored the network of streams and held undisputed sway over the valley for a period of about twenty years prior to 1844.

In 1843 a tract of land embracing over 48,000 acres, near the center of the area surveyed, and including the site of the present city of Stockton, was obtained from the Mexican Government, under the title of the Campo de los Franceses grant, by Capt. C. M. Weber, of San Jose.

This was followed by the arrival of a few early settlers and the founding of a few small colonies, the earliest farming being carried on along the Calaveras River. Early but temporary settlements were also made by the Mormons at French Camp and upon the banks of Mormon Slough. The city of Stockton was founded by Captain Weber in 1847.

With the rush of gold seekers to California immediately after the discovery of this metal in 1848, Stockton became one of the objective points and an important outfitting station for the mines. The population, although of a somewhat unstable character, rapidly increased, representing nearly all States and nationalities of the world. The most of these came by sailing vessels by way of the Horn, and found their way to the San Joaquin River.

Early efforts in agriculture were for the most part confined to stock raising. With the sudden increase in population, prices of farm products greatly advanced. Vegetables, hay, grain, and other staple crops were in demand. Some of those who came in quest of gold found their wealth only when, as a last resort, they turned their attention toward producing supplies for the mines. The growing of wheat in large tracts, however, became the main agricultural industry. Later barley came into favor, and the production of these two grains is still of leading importance. The use of farm machinery

consistent with the farming of
growth of this practice. Sailin
steam river packets. Then cam
an important manufacturing cen

With more recent immigration
more cosmopolitan character, an
cultural practices. Reduction o
declining yields, the occurrence
prices, has opened the way for
system of diversified farming,
vines, fruits, alfalfa, and the pr

Within the last few years th
rich peat lands of the western
idly, with the consequent improv
and the addition of the special
agricultural products of the earl

CL

The climate of the Stockton a
Joaquin and Sacramento valley
of two seasons, a wet and a dry,
ture, and widely in precipitation
relative number of clear days.

The normal annual temperatu
mal monthly temperatures vary
for the months of July and Au
of January. In the summer
quently reached during the da
and pleasant. During the win
weather, often accompanied by
Killing frosts may occur as ea
the month of April, but are us
and rarely are so severe as to int

The average annual precipit
taking place almost entirely du
April, inclusive. The rains com
or in rainy periods continuing
with periods of clear or foggy
violent storms, and thunderstorm

A condition of low relative
skies, generally occurs during t
than in the upper and drier por
however, greatly lessens the sen
days. Throughout the winter
laden with moisture during i

periods, and dense fogs are of frequent occurrence. During the night and early morning the fogs are generally dense, but they frequently disappear or lift during the day, sometimes continuing, however, as "high fog" for unbroken periods of several days, and even occasionally for weeks at a time. These winter fogs form a prominent local climatic feature of the great interior valley of California, and although obscuring the sun for long intervals, are unaccompanied by rain, are distinguished from ordinary cloud, and are considered in the official records as fair weather.

During the winter the winds are variable and light in character. During the summer season wind movement is dominated by the sea breezes, entering the valley by way of the Straits of Karquines, of moderate briskness, and greatly tempering the heat of the interior.

The climate is, as a whole, healthful and well adapted to the production of general farm and truck crops. A large proportion of the winter rains is retained by the soils to be used in plant production, while during the harvest season but little or no hindrance is experienced in farming operations because of unfavorable weather. The growing of the more tender fruits is rendered somewhat hazardous, owing to the occurrence of late warm winter periods sometimes followed by frosts, but hardier fruits and ordinary farm crops are unharmed by frost, while the hardier vegetables and truck crops, such as onions, cabbages, etc., are produced the year round.

The normal monthly and annual temperature and precipitation, as compiled from official data of the Weather Bureau, reported for the stations at Stockton, Lodi, and Tracy, the latter two located just outside the northern and the southern boundaries of the area, respectively, are shown in the following table:

Normal monthly and annual temperature and precipitation.

Month.	Stockton.		Tracy.		Lodi.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	*In.*	*° F.*	*In.*	*° F.*	*In.*
January	46.5	2.99	46.9	1.64	46.2	3.71
February	50.0	2.18	50.5	1.16	50.1	2.26
March	54.5	2.28	54.8	1.53	54.7	3.02
April	58.9	1.29	60.9	.95	58.3	1.27
May	64.1	.67	69.1	.55	63.4	1.36
June	69.9	.09	75.9	.18	69.1	.19
July	72.6	.02	79.9	.01	73.7	.00
August	73.5	.01	77.5	.01	73.0	.05
September	69.0	.14	72.0	.19	69.7	.46
October	61.7	.62	63.5	.60	62.3	1.42
November	53.9	1.76	54.2	1.15	53.6	2.49
December	47.1	3.36	49.6	2.16	47.3	3.56
Year	60.1	15.41	62.9	10.13	60.1	19.79

PHYSIOGRAPI

In general, the area survey variety, the most noteworthy drainage system. The elevati above sea level and below mean river-delta part of the area to s level at the northeastern extremi noticeable and the area is devo lines. Tree growth usually occu as groves, or as scattered indiv Drainage is effected by the San the Calaveras River and Morm and central parts of the area. branches of the main river, wit erse the western half.

Along the northern part of th just east from the towns of Lin the lower foothills of the Sierr valley plain and are included These first prominent foothill sl marked incline or of the lower, and ridges, covering only 1 or prominent features of this char

About one-half of the area s proper, at one time covered b cene lake or bay. The central westerly direction by the Cal the waters from both of which Stockton. Mormon Slough, so itself a branch of the Calavera tance outside the northwestern e nearly all the water which at Calaveras proper. Formerly water only during flood periods nel to artificial cuts made for creased by the erosive action of nial and captured the entire of diversion, except during fl course of Mormon Slough is f detritus derived from waste of carried by winter and spring fl Channel, forming bars and imp the harbor until removed. A the lower courses of Mormon S deflecting the bulk of the flood water into the Calaveras and depositing the stream-borne detritus in the San Joaquin River, where current and tide may assist in removing it.

Both the Calaveras River and Mormon Slough, except near their mouths, are narrow and deep. Flood waters of these two streams, aided by those from numerous minor intermittent streams, have in many places deposited extensive bodies of recent alluvial material over the valley floor. Lying to the south and eastward from Lathrop the outlying extremities of extensive deposits of fine and coarse sands of nearly level or gently undulating surface, locally known as the "sand plains," are encountered.

The San Joaquin River delta, a part of which is included in the western half of the Stockton area, consists of a vast tract of level swamp or "tule" lands, lying below the high-tide level of the adjacent streams. Numerous interlacing streams and sloughs divide the lands into tracts or "islands." This natural division is augmented by canals and cuts constructed in the progress of reclamation and navigation interests. Two prominent branches of the San Joaquin River, viz, Old River and Middle River, which, with the San Joaquin proper and many smaller sloughs, are navigable to river boats throughout the greater parts of their courses within the area surveyed, traverse the delta lands of the Stockton area. The soil consists of a light, loose Peat formed of river sediments mingled with accumulations of organic matter, the remains of partially decomposed masses of roots, stems, and fibers of aquatic plants. This soil, when drained and protected from tide and flood waters by artificial means, proves extremely productive. These finer river silts and sediments are continually deposited by flood waters upon the lands when not protected by levees, which with the growth and decomposition of vegetable matter effects a gradual extension of the delta toward the sea.

The materials entering into the various soils of the lower foothills, valley plain, and river delta are derived from the granitic, volcanic, and other altered rocks of the Sierra Nevada Mountains.

SOILS.

The soils of the Stockton area are mainly of alluvial or lacustrine origin, being deposited by subsidence from the waters of modern or ancient streams, lakes, or inland seas, or formed by the growth and partial decomposition of masses of aquatic vegetation mixed with stream or tide borne sediments. Naturally the degraded particles of a variety of rocks enter into the composition of these complex deposits. Only along the northeastern margin of the area surveyed do deposits of less complexity occur, as colluvial wash material distributed by heavy rains and streams and derived directly from the residual materials of the adjacent foothills.

The boundaries marking the v
tinct, related types passing into
In the accompanying maps suc
lines somewhat arbitrarily drav
bly productive and give large y
ods are followed.

The extent of the several typ

Areas of

Soils.	Acres.	Per c
Peat	107,584	3
Stockton clay loam adobe	53,312	1
Sacramento clay loam	41,088	1
Stockton clay adobe	40,832	1
Stockton loam	26,176	
Stockton silt loam	16,512	
Fresno fine sandy loam	10,304	
Fresno sand	9,536	

SAN J

The surface of the San Joaq
red plastic loam of fine, some
structure, with a depth ranging
It frequently carries gravel th
uniformly distributed. When i
upon cultivation into a loose loa
with a tendency to puddle an
part of the section the soil sud
properties of a heavy adobe.
inches, passing into an impervio
of fine texture and firm, dense s
be discussed further in a succee

The San Joaquin loam, while
hills of the Sierra Nevada Moun
in a few relatively small and
adjacent to its northeastern bo
of the lower or first foothill slo
nearly level valley plain. The
and devoid of rock outcrop or s
appearance of the underlying h

Natural drainage is favored
defined slopes of these soil bodi
generally free, percolation is gr
vented by the underlying har
quently collect and remain in
pelled by evaporation. The s

quently marked by wet and boggy spots and is often cultivated with difficulty. On the other hand, it frequently becomes compact, hard, and impracticable of cultivation before the advent of the winter rains. These conditions greatly limit the variety of crops grown and the period of successful cultivation of these lands.

The San Joaquin loam is derived from valley sediments of early Pleistocene age and from the weathered product of the complex rocks, generally of metamorphosed or altered character, of the Sierra Nevada foothills, the latter material being gradually transferred and spread about the valley margins through washing by torrential rains and streams. Some of these soil bodies are obviously modified by an admixture of recent alluvium. The soil and subsoil are free from alkali salts in injurious amounts.

In other parts of California soils of essentially the same characteristics as the San Joaquin loam have been successfully devoted to fruit culture, but owing to the shallowness in this area the type is suited only to the production of shallow-rooted crops. Grazing and dry farming to grain are the principal interests, the land being summer fallowed every other year. Owing to long-continued grain culture and to inadequacy of moisture supply occasioned by the occurrence of hardpan near the surface, light yields are obtained except in the most favorable seasons.

The following table gives the results of mechanical analyses of the fine earth of this soil:

Mechanical analyses of San Joaquin loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13072	Soil	1.0	6.6	6.0	16.7	15.8	35.5	18.8
13073	Subsoil	1.5	6.7	5.8	16.8	16.7	33.0	19.9

STOCKTON SILT LOAM.

The Stockton silt loam is subject to considerable variation in depth of soil and in the character of the subsoil, small, widely distributed bodies of fine silty loam occurring merely as superficial deposits over many of the other soils of the area. Typically, however, the Stockton silt loam is an extensive, important, and easily distinguished soil type, consisting of a fine, friable silty loam of light-brown color, extending to the depth of 6 feet or more, and becoming somewhat lighter in color and texture in the lower section of the profile. Although loose and friable when in proper condition, it becomes sticky when wet and may be rendered very compact. No gravel or other coarse material appears in this soil, except in the immediate vicinity of present or abandoned stream channels.

The Stockton silt loam cove
eastern part of the survey, whe
of irregular outline, most typi
Calaveras River. Other small,
of the other streams of the vall
and without variety, save for a
willows bordering the streams,
area flow in deep channels w
gradually into the Stockton lo
the other adjacent types. It i
taking place readily, but with p
ing a large supply of moisture.

Material derived from a gr
into the composition of the S
silty micaceous material, howe
the slates, amphibolites, and oth
Mountains, transported to the
of the streams in recent times.

A hardpan of calcareous na
channels cutting this type, bu
influence the growth of fruit
also free of alkali salts in injur

The Stockton silt loam is on
area and is well adapted to the
root crops, and hardy fruits.
barley, and oats, are grown, g
under proper cultural conditio
also yield well. Bramble frui
poses, and vegetables are grown
with considerable success.

The following table gives the
Stockton silt loam:

Mechanical analy

Number.	Description.	Fine gravel.	Coa sa
		Per cent.	*Per*
13077	Soil	0.2	
13078	Subsoil	.0	

FRESNO

The Fresno sandy loam varie
acter of the subsoil, but typical
feet of gray to light-brown san
ture, frequently carrying consi

sand particles. While usually loose and friable, the soil is sticky when wet and frequently becomes compact. At the depth of 3 feet this soil grades into a fine silty loam or silty clay loam. This subsoil also frequently carries some coarse material, is of a light-yellow or brown color, compact structure, and smooth and somewhat ashy texture, sometimes becoming sandy in the extreme lower part of the profile. The subsoil frequently carries concretions and is underlain at a depth of about 5 feet by hardpan, impenetrable to the soil auger or ordinary plant roots.

The Fresno sandy loam occurs mainly in a single body covering an area of some 8 square miles lying in the southeastern part of the area. A number of small and unimportant bodies also occur in the vicinity and southeast of Lathrop and French Camp. The surface is level or only very slightly rolling and is generally treeless. Some of the smaller bodies occur in slight depressions, while much of the larger area is low, flat, and somewhat poorly drained. This condition is augmented in places by the occurrence of hardpan. Considerable improvement may be effected in the case of the depressions and minor sinks by artificial drainage.

The Fresno sandy loam has been formed by the deposition of materials derived from the Sierra Nevada Mountains, and distributed over the valley plain by former streams. Considerable granitic material can be identified in the soil. Small quantities of alkali salts frequently occur, and particularly in the underlying hardpan, which not infrequently becomes the seat of, and in fact probably owes its origin somewhat to, the especially injurious alkali carbonates. While the quantity of these salts is generally not excessive, in a few cases it is sufficient to prove injurious to vegetation.

With irrigation alfalfa, fruits, and most ordinary farm crops should do well upon this soil wherever the hardpan does not approach the surface too closely. At present grain hay and grain are grown, without the aid of irrigation, giving fair yields in favorable seasons. The growing of these crops and of alfalfa under irrigation is becoming more important from year to year, and is much more profitable than under the old system of dry farming.

The following table gives the results of mechanical analyses of a typical sample of the soil and subsoil of this type:

Mechanical analyses of Fresno sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13074	Soil	2.9	13.2	6.5	17.1	16.7	31.1	12.4
13075, 13076	Subsoil	3.7	14.4	6.9	17.7	14.9	29.6	12.5

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 13076, 2.18 per cent.

FRESNO FI

The Fresno fine sandy loam co
sandy loam of fine ashy texture
very smooth and quite sticky wh
The ashy texture and compact
depth of about 3 feet or 3½ fe
stratum is frequently encounter
soil section is sometimes consic
overlying soil.

The Fresno fine sandy loam
occurs in the southern part of t
Camp, Lathrop, and Atlanta, u
extending in a northwesterly an
face is usually low, flat, some
treeless, and without distinctiv
position and the presence of ha
and percolation is arrested, poo
the roads and fields for a long ti

The origin and mode of forn
same as that of the Fresno sand
grade. As in that type, alkali
eral occurrence. They are usual
or compact subsoil, and in de
accumulated at the surface in s
ordinary farm crops.

A considerable area of the Fre
condition, adapted only to gr
natural drainage and where the
tinuous or lies at some distance
and probably vines and small fr
if care be taken not to apply
present the type is devoted main
grains and grain hay.

The following table gives the
typical sample of the soil and th

Mechanical analyses o

Number.	Description.	Fine gravel.	Coars sand
		Per cent.	*Per ce*
13053	Soil	0.0	2
13054	Subsoil	.2	2

The following sample contained more th
(CaCO$_3$) : No. 13054, 1.36 per cent.

FRESNO SAND.

The Fresno sand consists of a light-gray or light-brown sand of medium texture and loose incoherent structure, and extends to a depth of 6 or more feet. The soil throughout the section carries considerable coarse angular material.

This type occurs in a very irregular body, with relatively long and narrow projections extending in a general northwesterly and southeasterly direction to the south and east from French Camp and Lathrop. It covers a considerable area, and in the southern part of Twp. 1 S., R. 7 E. it is the prevailing type of soil. The surface is generally slightly rolling, treeless, and unmarked by vegetation except wild grasses and a great variety of brilliantly colored wild flowers appearing during the early spring. The soil passes gradually into the adjacent fine sands and sandy loams, and includes bodies of these soils too small to be shown upon the map.

Owing to its position, character of surface, and open, porous texture, this soil is naturally very well drained. Lower lying areas and depressions may, however, become saturated and rendered unproductive from a too copious use of irrigation waters upon the higher slopes, and there are already instances of impairment of the lower lying lands from this cause.

As in the case of the adjacent soils the materials forming the Fresno sand originally came from the weathering of the rocks of the Sierras. The wash from these has been transported by streams and distributed over the valley plain in gently sloping fanlike forms. The materials forming the Fresno sand, however, are believed to be mainly derived from granitic rocks.

Owing to the good natural drainage and to the loose open structure of the soil, it is free from injurious alkali salts. The soil, however, retains little moisture and therefore is hardly a satisfactory soil for grain or shallow-rooted crops without irrigation. Where irrigated, it is well adapted to alfalfa and general forage crops. Cherries, peaches, small fruits, and early truck crops would also prove profitable. Alfalfa and grain are the principal crops grown at present. Alfalfa, which is grown with the aid of irrigation, yields well. The yield of grain, dry-farmed, is generally very light.

The following table gives the results of mechanical analyses of a typical sample of the soil and the subsoil of this type:

Mechanical analyses of Fresno sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13049	Soil	5.6	23.7	19.8	30.4	12.3	4.8	3.0
13050	Subsoil	1.9	19.9	18.6	34.3	15.9	5.7	3.7

FRESNO FINE SAND.

The Fresno fine sand consists typically of a light-yellow or light-brown micaceous sand of fine, smooth texture and open, porous structure, extending to the depth of 6 or more feet. In the Fresno fine sand of the Stockton area the lower part of the soil section is frequently slightly heavier and somewhat more tenacious when wet than nearer the surface. It is usually free from gravel or other coarse material, except where there is an admixture of the adjacent Fresno sand.

The Fresno fine sand is found in several long, narrow areas associated with the Fresno sand and Fresno fine sandy loam south and southeast of French Camp. The surface is generally nearly level or only slightly uneven. The native vegetation is similar to that of the Fresno sand, consisting of grasses and flowering weeds.

While the areas of Fresno fine sand are only slightly above adjacent soils of somewhat deficient drainage, percolation, evaporation, and lateral movement of the soil water is rapid. The soil is somewhat deficient in moisture-retaining properties, and frequent cultivation becomes of great importance in conserving moisture for the use of the crops.

In origin and mode of formation the Fresno fine sand is similar to the Fresno sand, micaceous granitic material predominating. It is free from alkali salts in injurious quantities, although the deeper subsoil contains small quantities, which under excessive irrigation, coupled with insufficient cultivation and drainage, might in time become concentrated at the surface in sufficient amounts to prove injurious to ordinary crops. There is generally no hardpan formation in this soil within the depth of 6 feet.

The Fresno fine sand is best adapted to the growing, under irrigation, of alfalfa, forage crops, or hardy fruits, requiring a loose, well-drained soil. It is generally devoted at present to grazing and to the growing of alfalfa and grain with and without irrigation, the yields being generally slightly better than those obtained from the Fresno sand. This is especially true in the case of the dry-farmed areas.

The following table gives the results of mechanical analyses of a typical sample of the soil and the subsoil of this type:

Mechanical analyses of Fresno fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13051	Soil	0.9	6.2	8.5	34.6	28.3	15.8	5.6
13052	Subsoil	.7	5.9	9.1	34.7	28.7	15.8	5.0

SAN JOAQUIN SANDY LOAM.

The San Joaquin sandy loam consists of about 30 inches of sandy loam of medium texture and of light-red color, underlain by an impenetrable hardpan of fine texture and dense structure. The coarser particles in the soil are angular and sharp and tend to give it a friable structure when in a favorable condition, but when wet the materials become sticky, with a tendency toward puddling and baking. The lower part of the soil becomes slightly heavier in texture and more compact in structure, the 4 inches immediately above the hardpan containing considerable clay and exhibiting the structure of adobe. While the average thickness of the soil covering is 30 inches, the depth to hardpan is subject to some variation.

This soil occurs only in a single extensive and uniform body east of Ellisworth in the southeastern part of the area. The surface is treeless, except in the vicinity of minor stream channels, is sometimes marked by slight depressions, and slopes, in general, slightly to the northwest. While occupying a more favorable position for drainage than many of the soils of the area, as in the case of the San Joaquin loam, the percolation is checked by the underlying hardpan, and drainage in the lower depressions and in areas of slight inclination is deficient.

The San Joaquin sandy loam owes its origin probably to deposition of the material originating in the rocks of the Sierra Nevada Mountains, in the waters of an ancient Pleistocene lake or bay, the material being modified by later alluvial wash and by the secondary hardpan formation. Alkali is not found in injurious quantities in the soil.

Owing to the presence of hardpan the San Joaquin sandy loam is not adapted to fruit trees, alfalfa, or other deep-rooted or heavily irrigated crops. Grain hay and grains, grown without the aid of irrigation, are the principal crops, the yields being fair in favorable seasons.

The following table gives the results of mechanical analyses of a typical sample of the soil and the subsoil of this type:

Mechanical analyses of San Joaquin sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13059	Soil	4.5	18.9	8.9	15.5	14.8	25.4	12.3
13060	Subsoil	2.8	16.7	8.5	15.7	13.5	23.6	18.8

STOCKTON LOAM.

The Stockton loam is subject to considerable variation in color, texture, and character of soil and subsoil. Typically it consists of 6 or more feet of light chocolate-brown to nearly black loam of medium

texture and of somewhat comp
the section is somewhat lighter
although the subsoil frequently
is easily cultivated and friable
but becomes sticky when wet an
areas occur in which the texture
that of the adjacent soil, the St
types.

The Stockton loam is a type o
occurring in irregular bodies in
survey. The larger and most ty
ton and in the vicinity of Wat
bodies frequently occur along str
surface is usually level or only sl
above the adjacent heavier soil
during seasons of heavy rains, b
factory during the growing an
depressions occur which would b

A light sandy phase of this s
consists of a light loam of dar
amount of rather coarse, loose
feet by the loam of fine silty te
in the typical soil. This phase o
mounds or ridges, usually in the
channels. The largest area is fo
area about 7 miles northwest of t
is generally well drained, free
of moisture than the typical s
features.

Like the adjacent soils of the
alluvial origin, resulting from t
ments, in ancient lakes or bays,
ture of more recent sediments la
sesses in a high degree the power
cultivation may be rendered cap
during long periods of drought.
salts, although small patches oc
deficient drainage, where the sal
rious quantities at or near the s
ever, in the aggregate of but re

The Stockton loam is well a
stone fruits suited to the climate
and other vegetables, grain, and
last named, grown without irr
The yields are generally good, u
To some extent vegetables and
the vicinity of Stockton.

The following table gives the results of mechanical analyses of a typical sample of the soil and the subsoil of this type:

Mechanical analyses of Stockton loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13055	Soil	0.5	5.3	8.4	25.4	18.7	22.2	19.9
13056	Subsoil	.1	7.3	12.8	31.2	17.0	18.8	13.2

STOCKTON LOAM ADOBE.

The soil of the Stockton loam adobe consists of a heavy, black clay loam adobe, extending to the depth of about 30 inches, and containing a considerable admixture of sand, consisting mainly of coarse angular white particles. This is underlain to a depth of 6 or more feet by a fine silty or silty clay loam of light-yellow color. The soil is of a very dense compact structure and frequently checked upon the surface. It becomes very sticky when wet, and unless properly cultivated puddles readily and bakes upon exposure.

The Stockton loam adobe occurs only in a single body, and that of limited extent, lying north of Stockton and along the northern margin of the area. The surface is generally nearly level or only slightly uneven, and marked by an occasional clump of valley oak or by willows in the vicinity of stream channels. By gradual diminution in the proportion of sand the soil grades into the other adobe lands lying to the south.

Owing to relatively low position and to the compact structure and heavy texture of the soil, natural drainage is frequently deficient, especially during and following seasons of heavy rains. Artificial drainage is sometimes resorted to and might be further extended with beneficial results.

Deposits from ancient lakes or bays with the later addition of sediments from streams, modified by the various agencies of weathering, have given rise to this soil. The original materials have been derived from a great variety of rocks, as in the case of nearly all the soils of the area. No hardpan formation seems to occur and alkali salts only in very small quantities, though the latter are sufficient to increase somewhat the tendency of the soil to puddle. The fields are marked by small light-colored spots, which appear upon cultivation and are believed to be due to peculiarities of physical structure, probably induced by the action of small quantities of soluble salts. These light-colored spots are frequently less productive than the rest of the field.

This soil is probably best adapted to grazing and the growing of alfalfa, grain, hay, and forage crops, the purposes for which it is at present used.

The following table gives
typical samples of the Stockton

Mechanical analy

Number.	Description.	Fine gravel.	Co s
		Per cent.	*Pe*
13061	Soil	0.5	
13062	Subsoil	.6	

The following samples contained mor
($CaCO_3$) : No. 13061, 1.45 per cent; No

STOCKT

The Stockton clay adobe co
black heavy clay adobe, with
lain to a depth of 6 or more
silty clay texture. The soil is
highly upon the soil auger, i
puttylike consistency when w
blocks by deep surface cracks
checking, the larger blocks a
checks and cracks, causing the
a loose mass of small blocks a
larger.

The subsoil is of much less
soil, but is very sticky when we
concretions or incipient hard
frequently contain small suba
gravel.

The more extensive and typ
occur near the eastern part of
and Collegeville. Many small
tered throughout the eastern h
nearly level, and without dist
occasional growth of valley o
loams and the heavy and den
to unfavorable position and t
natural drainage is generally
operations and even travel ove
temporarily suspended.

The Stockton clay adobe in t
tion over the valley floor of ve
from a great variety of roc
ancient Pleistocene sediments.

Owing to the texture and
arrested and the soil when d

however, capable of holding a great amount of water when saturated, which is slowly given up under evaporation. Under proper methods of cultivation it is thus able to retain much moisture throughout the dry summer seasons, and to supply the crop needs during prolonged droughts. The soil is also generally free from impervious hardpan or alkali salts in such quantities as to become detrimental to crops. The small light-colored spots noted in the description of the Stockton loam adobe are also of frequent occurrence in the type under discussion.

This soil is not generally well adapted to early vegetables or fruits, or to crops requiring a light, well-drained soil. It is best suited to the production of alfalfa, forage crops, grain, and grain hay. Dairying and stock raising should be profitable industries where the trampling of the soil in wet seasons by stock can be avoided. Alfalfa, grain hay, and grain are the principal crops now grown, the yields being generally good or relatively heavy in favorable seasons. Vines, tree fruits, and vegetables are grown to a limited extent upon lighter phases of the type in the district lying northeast of Stockton, with fair yields under careful cultivation and attention.

The following table gives the results of mechanical analyses of typical samples of the soil and the subsoil of this type:

Mechanical analyses of Stockton clay adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13063	Soil	0.4	1.5	1.6	7.5	12.3	36.4	40.2
13064	Subsoil	.3	1.9	1.9	8.1	12.0	33.1	42.8

STOCKTON CLAY LOAM ADOBE.

The Stockton clay loam adobe consists of a black clay loam adobe, similar in structure features to the Stockton clay adobe, but of smoother texture, being generally free from coarse or gritty material. It polishes highly upon the soil auger and assumes an exceedingly tenacious, waxy or stiff, puttylike consistency when wet. During the dry season the checking of the surface is often developed to a remarkable degree. It is underlain at about 3 feet by a yellow heavy silty or silty clay subsoil, becoming lighter in the lower part of the section and similar to that of the Stockton clay adobe. The surface of the subsoil in the more southerly lying bodies is frequently somewhat compacted and partially cemented immediately below the overlying soil into a soft, imperfect hardpan or separated from the overlying soil by a thin white crust of relatively soft, calcareous hardpan.

The Stockton clay loam adobe is one of the most important soils of the area, occurring in the most extensive and typical bodies to the

The type is subject to considerable variation in depth, texture, character of subsoil, and in the relative amounts of silt and organic matter. In the vicinity of the adjacent peat lands it is underlain by the partially decomposed peat instead of by the yellow silty loam subsoil, as described. A silty clay phase also occurs in a few small areas in the vicinity of the San Joaquin River and some of its larger tributaries. This phase consists of a deposit of from a few inches to 2 feet or more of a light yellow, very fine, heavy silty or silty clay loam, very sticky when wet, and of rather compact, dense structure, underlain by the peaty and silty loam materials of the typical soil. It is similar to the typical soil in most other particulars, but is of a more refractory, denser texture and structure and requires more careful preparation and cultivation.

The Sacramento clay loam is an extensive and important soil type, occurring in the central and southwestern parts of the area. The surface is generally level or only slightly inclined, and treeless, except in the vicinity of the streams. The depressions, which are of deficient drainage, are usually marked by a growth of tules or rushes. The soil passes gradually into the adjacent peat lands, adobes, and loams.

Percolation is sometimes retarded by the compact structure of the subsoil, which, with the low-lying position and gentle slope, often results in insufficient natural drainage, and open drainage ditches are frequently encountered in the cultivated areas of this type.

The Sacramento clay loam owes its origin to the admixture of the fine river silts, derived from a variety of rocks and distributed by the San Joaquin River and its tributaries and branches, with the fine alluvial and decomposed organic matter of the tidal fresh-water marshes or peat lands. The material from these two sources is either intimately mixed or deposited in alternating strata. The soil is generally free from alkali salts in injurious quantities, and under proper cultivation possesses valuable moisture-retaining properties.

While containing a large amount of organic plant food, and generally productive, the crop yields decline where a single crop is grown continuously. When the water table is not too close to the surface, the type is best adapted to alfalfa, to grass and forage crops—such as redtop, rye grass, timothy, some of the clovers—and to root crops, beans, vegetables, and grain. Much of this land is admirably adapted to dairying and stock raising. Small and tree fruits, consisting of peaches, apricots, pears, and cherries, also do well in the higher and better drained areas of lighter texture.

Grain hay and grain, consisting of wheat, barley, and oats, are the principal crops, the yields being usually good. Alfalfa, in connection with dairying and stock raising, is also grown in limited quantities. In small, favorably situated bodies, especially in the vicinity of the tough roots of aquatic plants. No gravel or other coarse material appears in either soil or subsoil.

This important soil type occurs only in the San Joaquin River delta region, where it covers the greater proportion of the entire western half of the area surveyed. The topographic and drainage features, mineralogical origin, and mode of formation are much the same as in the other soils of the lower delta. The drainage conditions will be discussed more particularly under the succeeding heading.

Extreme lightness in weight constitutes a very striking feature of the Peat, large fragments frequently becoming detached and floating about with the stream and tidal currents.

The soil carries a great supply of plant food and under favorable conditions yields enormously. This has given rise to the belief that the soil is capable of continuously producing all manner of crops, without regard to the principles of ordinary farm management or crop rotation. This belief is not borne out by agricultural practice. While ranking among the most productive soils known and while maintaining this productiveness, when farmed under ordinary, careful, modern methods, the long-continued growing of successive crops of grain, as in the case of other soils, is resulting in decreased production. The profitable growing of successive crops of potatoes is said to be limited to three or four years.

The accidental ignition of the Peat from "tule fires," or in other ways, often proves troublesome, the organic material of the soil slowly smoldering until practically removed, unless the fire be checked by flooding. This leaves the soil a mere bed of red or light-colored ash, and greatly reduces its value, and, moreover, increases capillary movement and rapid evaporation from the surface, resulting frequently in the surface accumulation of alkali salts in injurious quantities. When not modified by ignition, the capillary or upward movement of soil waters takes place so slowly that the application of irrigation waters to the soil surface frequently becomes necessary during the dry season, although the soil may be saturated with water at the depth of 3 or 4 feet, or even less.

While alkali salts exist in these soils and in the surface waters in considerable amounts, under ordinary conditions they are not of sufficent concentration to become injurious to ordinary crops, and their accumulation in harmful quantities takes place only through the destruction of the natural, coarse, mulchlike structure of the soil.

The Peat is generally ill adapted to the growing of alfalfa or other deep-rooted crops, owing to the close approach to the surface of the water table. On the other hand, it is admirably adapted to certain special crops, such as asparagus, beans, onions, or other vegetables, forage crops, timothy, redtop, ryegrass, some of the clovers, and to potatoes or grain. The risk of damage to crops and lands from fires

Throughout the eastern-central part of the area a much less intractable and therefore less injurious hardpan occurs. It is found within the zone of ordinary root development only in the case of some of the lower lying, heavy adobe soils, and amounts merely to partial cementation of the underlying heavy loam subsoil by lime carbonate. A thin white crust of true lime carbonate hardpan of quite dense structure frequently separates the soil and subsoil. Both this crust and the underlying compact and partially cemented subsoil are penetrated by the soil auger and probably frequently by the roots of trees and field plants. It lies uniformly at a lower depth than the hardpan first described, which is another reason why it is much less injurious in its effects upon crops.

The white hardpan of the Fresno fine sandy loam occurring in the southern and eastern parts of the area is, however, of a more dense and firm character and of greater importance in its influence upon growing crops. This material consists of a firm white stratum, usually only a few inches in thickness, of fine texture, and ashy consistency when pulverized. It softens slowly upon application of water. Several of these strata may occur separated by the unconsolidated soil. Much of the fine ashy material is probably of volcanic origin, rich in alkali salts, and consolidated by lime and alkali carbonates. It does not approach the surface so closely as to interfere with plowing or other cultivation, and is much less extensive, uniform, and continuous than the red hardpan found in the eastern part of the area. It is of importance mainly as being the seat of much of the injurious alkali salts of this district and in its effect of retarding the removal of such salts by the drainage water.

While no areas occur in the Stockton area that may be properly designated as "worn-out" lands, the productiveness of certain soils of the valley and delta has been decreased by continued cropping to grain or other crops. In such cases, a more careful system of culture, the rotation of crops, the production of fat stock and farm animals, and the practice of a more diversified system of farming are to be recommended where consistent with location and with climatic and soil conditions.

The improvement of the areas of "burned-out" Peat is also a matter of importance. Careful management is necessary to bring these patches to their former state of productivity. The addition of coarse animal and vegetable manures and the culture of clovers, forage crops, and the practice of green manuring is recommended.

RECLAMATION OF SWAMP LANDS.

It is to modern engineering skill in the erection of levees and the drainage of the delta or swamp lands covering the most of the western portion of the Stockton area that this extensive district owes its agricultural importance. Lying but a few feet above low-tide

In draining areas inclosed, the water is pumped over the levees from artificial drainage channels or from minor natural sloughs serving that purpose. For this work pumping plants are employed, either permanently located near the levee or installed upon barges and towed from place to place. The small plants and those of medium size are usually permanent and are operated by gasoline or by steam generated with crude-oil fuel. The larger plants used in the first freeing of the tracts of the flood waters frequently consist of batteries of powerful centrifugal pumps. These are operated by steam and are sometimes installed upon floating barges, which are particularly serviceable from the ease with which they may be moved from place to place.

While extensive tracts are still partially or wholly unreclaimed, practically all the lands lying within the Stockton area are reclaimable and will doubtless soon be rendered capable of cultivation.

WATER SUPPLY FOR IRRIGATION.

For many years irrigation in the vicinity of Stockton was generally considered unnecessary. With the introduction of fruits and other specialized crops, however, the artificial application of water often proved very beneficial. The building up of the dairying industries, fostered by the growing of alfalfa, rendered irrigation a necessity, for although in the growing of fruits and vegetables much may be done with an intermittent or limited water supply supplemented by frequent cultivation, the growing of alfalfa calls for a more extensive system, cheap and abundant supply, and thorough and regular application.

The great part of the area surveyed still remains unirrigated, but the practice is becoming more common with the development of intensive agriculture. The water used for irrigation is derived partly from the streams and partly from a subterranean source. In the southeastern part of the area a considerable acreage is covered by the lower branches of an extensive system of canals and laterals, the water being taken from Stanislaus River. Another system of considerable proportions, taking water from the Calaveras River near Stockton, passes through the north-central part of the area. Most of the water afforded by this latter system is, however, applied in the vicinity of Lodi and Woodbridge, which are some distance north of the limits of the district mapped.

Alfalfa is the principal crop irrigated under these systems in the Stockton area. While the water supplied by them is sometimes limited in amount, there is in general, particularly under the system taking water from the Stanislaus, more than enough for the area cultivated, so that if a tendency toward the reckless and too lavish use of irrigating waters could be checked the area irrigated could be here greatly extended.

Irrigation upon the delta la
level of the adjacent streams is
the streams through head gate
tables, and the special crops o
water in this manner, for alth
surface in this district, capilla
soil becomes very dry during t
character of the stream water
for irrigation purposes, is hig
from an underground source is
plants operated by electricity
crude-oil fuel. While tracts s
aggregate a considerable area
vegetables, and fruit irrigated
from the first water-bearing s
in purity to that taken from t
third stratum, tapped by the
tively free from soluble salts,
irrigation.

UNDERGROUND

The character of the under
some indication of the quantit
salts in the subsoils, such salt
the water of wells or springs.

In the western section of th
in the vicinity of Holt and w
quently carries in solution rela
indicating their presence in th
sodium chloride, or common ta
ties. In certain districts, how
salts predominate, and many
these salts as to be unfit for do
nate in marine deposits of a
occurring in some quantity in
conditions need occasion no ala
the soil is not disturbed.

The occurrence of seepage w
due to the immoderate use of
water by leakage or seepage th
voirs, coupled with natural c
usually leads to a condition of
lower slopes, the formation of r
ing pools, and unproductive m

Although profuse irrigation
before the appearance of these

under conditions favoring their appearance the tendency is always toward their rapid increase in number and extent. While such extreme conditions as occur in many heavily irrigated districts are not apparent in the Stockton area, there are a number of small spots and local depressions lying in the southeastern portion of the area that have been subject to considerable injury in this way.

Unless greater economy be practiced in the use of water it is feared that areas of seepage lands, at present not extensive, may rapidly increase. An outlet should also be provided for these local areas of naturally deficient drainage by construction of open ditches, or preferably by tile drains, of sufficient capacity to remove the excess soil or seepage waters from water-logged slopes and flooded sinks and convey them into natural or artificial channels leading to the larger streams.

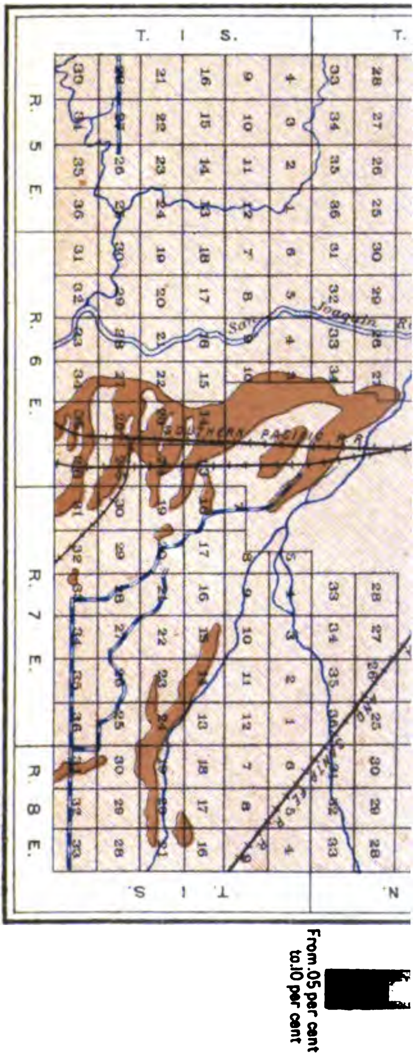
ALKALI IN SOILS.

Alkali salts exist in injurious quantities in only a relatively small part of the soils of the Stockton area (see colored Plates I and II). In the vicinity of Stockton an occasional small patch sometimes appears. This condition is especially noticeable in one or two localities along the Linden road. Areas of slight concentration also occur immediately northwest of Stockton and along the edge of the swamp lands. The main alkali areas are found in the southern and southeastern parts of the area, usually in areas of the Fresno fine sandy loam and also in limited areas of reclaimed Peat lying a short distance west of Rough-and-Ready Island.

Excluding the deposits in the peat, where the alkali salts have been derived from marine sediments, the alkali of the Stockton area is derived from the eruptive or altered rocks of the Sierra Nevada Mountains, from the volcanic ash material occurring to a great extent in the soils of the central part of the San Joaquin Valley, and from the hardpan subsoil of the Fresno fine sandy loam. Although termed " alkali " salts, very few of the salts common in the Stockton area are true alkalis; that is, of alkaline reaction. Sodium chloride and sodium sulphate are of common occurrence. The truly corrosive and much more highly injurious sodium carbonate also usually appears wherever the total salt content is high enough to threaten crop production. In considering the injurious effects of alkali, 0.20 per cent is considered as the minimum limit of danger for ordinary irrigated crops, this amount, while not greatly in excess, usually decreasing yields of crops to a certain extent, and causing the appearance of frequent barren spots. In the case of the sodium carbonate or " black alkali," however, 0.05 per cent is considered the minimum concentration beyond which crops begin to suffer.

The relative concentration and distribution of these salts in the soils and subsoils depend upon a variety of circumstances, but

REPORT OF BUREAU OF SOILS U.S. DEPT. A



From .05 per cent to .10 per cent

JULIUS BIEN & CO. N.Y.

BLACK ALKALI MAP, STOCKTON SHEET.

largely upon the soil texture and
ground water table, and the rapi
of the soil water. In soils of
under influence of gravity move
water in excess of saturation by
dissolved and carried downward
ture and compact structure the
influence of evaporation upwar
supplying moisture from the su
evaporation. Conditions favor
continued capillary movement—
dry weather, compact, uncultiva
a water-logged condition of the
water table near the surface, a
use of immoderate quantities
levels—tend toward concentratio
soil surface. On the other hand
tion of a soil mulch, the checking
ment, the heavy application of
irrigation, together with conditio
soils, tend toward the removal
the Stockton area the alkali sal
near the surface. Occasionally t
the underlying hardpan, but r
alkali salts in injurious amounts

Several methods have been p
reclamation of alkali lands. Th
consists in thorough underdraina
ing of the surface. As soon as
thorough cultivation should be e
alkali-resistant crops, which can
shade the surface—such, for in
alfalfa.

In the case of the alkali areas
ing, followed, as soon as the soi
surface, should prove beneficial.
as possible should be incorporate
ing of forage crops to prevent e
face should be undertaken as so
the case of the local alkali spot
east of Stockton, the practice o
making heavy applications of
beneficial, improving the soil str
tion and consequent concentratio

AGRICULTURAL METHODS.

The Stockton area presents wide variation in agricultural practices, which range from those applicable to the most extensive to the most intensive systems of farming. In general, the methods employed are well adapted to the soils and conditions of the area, though improvement is possible in the methods of irrigation, cultivation, and the care of crops in some sections of the area.

Upon the larger ranches and tracts labor-saving machinery has attained a wide degree of usefulness. In the case of many of the smaller tracts devoted to market gardening and truck growing, the most of the labor is performed by hand by Italians, Chinese, and Japanese, although a wider use of light machinery and garden tools would frequently prove more economical and efficient.

Plowing upon the extensive grain-producing tracts is done with the gang plow in common use throughout this section of the State. While the seed bed is sometimes carelessly prepared, this field operation is in general carried on with greater thoroughness and diligence than in many other extensive grain-growing sections. Plowing, harrowing, and seeding operations take place during the winter months, the grain being sown by drilling or sometimes by broadcasting machines. Combined harvesters are in general use all over the larger tracts, some of which it is reported can harvest, thrash, and sack the grain from a hundred acres in a day at a cost of 14 or 15 cents per 100 pounds. In the low-lying island districts devoted to grain culture farming operations must be carried on with due regard to the moisture and drainage conditions of the spongy Peat soils. Untimely rains or floods occasionally render the soil too wet and soft to allow preparation of the land or harvesting of the crop, although under recent improved conditions of the levees this unfortunate condition does not often occur.

Upon newly reclaimed or soft tracts work horses are commonly provided with peat or "tule" shoes, offering increased surface resistance and preventing the sinking of the animal into the spongy land. Powerful traction engines, built in the form of an immense tricycle and provided with auxiliary rollers or traction wheels 4 or 5 feet wide, are also extensively used to compact the soil. One of these modern machines performs the work of many horses in hauling a series of gang plows, harrows, and grain drills, plowing, harrowing, and seeding the land at one operation. They are also again brought into requisition in hauling the combined harvester during the harvest season, in repairing and improving the public roads, and in hauling heavy loads. Modern labor-saving machinery likewise plays an important part in the production of some of the special crops grown in large tracts in the island district, although its use is here subject to greater natural restrictions.

Preliminary clearing of the P ing the tules flat, after which th be exercised not to ignite the organic character may be largel unproductive, and filled with de

Rotation of crops and the use lizers are not practiced to any farmed tracts.

Irrigation as applied to the c usually carried on by the small which is well adapted to the sc Upon the lighter soils of the so ever, the lavish use of irrigating if unchecked must result in flood sions with seepage water, thus re

The delta lands devoted to the and other special crops are ir being simply allowed to flow t tapping the levee. While such heavily impregnated with alkali movement, it here proves a saf applying water to the land.

Upon the small tracts of the isl devoted to the growing of veget tions of plowing, harrowing, and usually quite thorough. Some efficiently and more quickly pe machinery. Cultivation of the neglected, the growth of noxio wild mustard, allowed to go on u operations overlooked. In harve and other special crops the meth of study and imitation. Barn applied to the smaller vegetabl essential to increase the plant f ture of the heavy soils and pron is too frequently neglected in extended to most field crops.

The benefits of frequent and t proper condition of tilth in th evaporation and conserving soil n and in checking the accumulatio at the surface of some of the ligl of the area, are of especial impor

AGRICULTURAL CONDITIONS.

The value of the farming lands of the Stockton area is increasing rapidly. The farms of the older settled districts, particularly those of the northeastern part of the area, present a neat and orderly appearance, and excellently tilled fields, well-built fences, and substantial and commodious farm buildings bespeak the prosperous and contented condition of their owners. In other less favored parts of the area an occasional vacant or abandoned farm dwelling is seen, indicating that the land, usually devoted entirely to dry-farmed grain, is rented and farmed by some neighbor or nonresident, the buildings sometimes being used merely temporarily by the hired hands during the harvest season. In the recently reclaimed districts of the islands and in many of the smaller tracts of recent conversion to truck farming, dairying, and intensive agriculture the buildings are frequently very modest, of cheap construction, or merely temporary affairs of rough boards, characteristic of newly settled districts.

There is, in general, upon the part of the farming classes, a desire to improve their condition, and to take advantage of modern conveniences and labor-saving devices. Much of the area is covered by rural free mail delivery routes and many of the more isolated farm dwellings are connected by telephone.

While quite extensive districts within the alkali belts bordering the swamp or tule lands and also in the southeastern part of the area are valuable in their present condition only for grazing purposes, the area of worthless lands or those incapable of being brought under profitable cultivation is very small.

Upon the older reclaimed portions of the islands farmed by the actual owners, good farm buildings are of frequent occurrence, but much of this district is as yet held in large tracts and rented for a cash consideration of from $6 to $15 an acre per annum, the tenants, mainly Italians, Chinese, and Japanese, often occupying poor or squalid quarters. This section could, if divided into small tracts, and devoted to dairying and intensive agriculture and farmed by actual owners, be rendered capable of supporting a large population. Many of the large grain-producing tracts of the valley are also rented upon a cash or crop-percentage basis. Statistics show less than half the number of farms of San Joaquin County to be operated by the actual owners. This condition is not in keeping with the opportunities offered in this section for the practice of diversified farming, dairying, and stock raising, or the growing of special crops in small tracts.

In certain districts, particularly in the southeastern part of the area, grain farming is being supplanted by dairying in connection with the growing of alfalfa and other farm crops. Notwithstanding the great number of small tracts devoted to dairying and to vegetable and fruit production, owing to the existence of the many large valley farms and extensive island tracts the average size farm in San Joaquin County, according to the census of 1900, is 382 acres. This is more than ten times as great as the average size farm in some other of the irrigated districts of the West, the natural advantages of which are far less favorable to crop production in many respects of soil and climate. While not all the lands of the Stockton area, if intensively farmed in 20 or 30 acre tracts, would be capable of supporting a family, many of them would do so, and the average size farm may well be reduced coincidently with the further development of agricultural industries. Many of the Italian vegetable gardeners, by great thrift and unremitting labor, succeed in supporting large families and in accumulating a small competence upon only a few acres, and, in general, small or medium sized farms devoted to diversified farming with dairying, stock, or poultry raising, and the growing of fruits and vegetables upon a small scale, are more to be recommended to intending settlers, especially to those unacquainted with all the peculiar features of climatic and industrial conditions of the country, than the more extensive farming of larger tracts.

Upon the valley farms the general farming operations are usually intelligently performed by white labor at prices current upon the Pacific coast. Upon the extensive rented island tracts much of the labor is performed by Chinese and Japanese. In the raising of fruit and truck crops Chinese and Italian labor predominates. During the grain and fruit harvest season much extra labor is required and is frequently performed by nomadic laborers of mixed races and of a less reliable class. In ordinary teaming and in the use of farm machinery white labor, while usually somewhat more costly, is preferred. The more tedious hard labor necessary in the growing of truck crops and fruits is generally performed by the Latin races and Asiatics.

The production of grain is still the most generally practiced agricultural industry of the Stockton area. Wheat is the most important grain crop, followed in magnitude by barley and rye in the order named. The great part of the valley lands and extensive areas of the older reclaimed island tracts are devoted to this industry. A relatively constant rainfall, together with productive soils, renders this section probably the most important grain-producing district and shipping center of the San Joaquin Valley. While the wheat produced is of fair weight and quality, it is, in common with all California wheats, somewhat deficient in gluten content and consequently of inferior milling qualities. Experiments conducted by State and Federal authorities are now in progress by which it is hoped to produce strains of wheat of satisfactory milling qualities.

The other principal crops of the valley lands consist of alfalfa, table and wine grapes, and deciduous fruits, mainly almonds, peaches, apricots, and cherries. Almonds are especially productive and profitable when properly cared for and when not subject to injury from the frequent spring frosts, the planting of the hardier stock being advised in all cases. Choice early table grapes are usually in good demand and salable at prices giving large profits. The acreage of the vineyards is, however, being rapidly extended, and with the greatly increased product the returns from ordinary or late table grapes or wine grapes leave a narrow margin of profit, and this industry should be carefully studied before embarking in it extensively. The main fruit and grape-producing sections lie in the eastern and northern parts of the area.

Among other important crops of the delta lands, potatoes, beans, onions, asparagus, and other truck crops are produced in great quantities. Potatoes, beans, and asparagus are probably the chief crops of the newly reclaimed lands, potatoes being generally planted as the first crop. The yield and value per acre in San Joaquin County, according to the United States census of 1900, is as follows: Beans, 35.5 bushels, valued at $55.03; potatoes, 124.1 bushels, valued at $62.05 and onions, 402.2 bushels, valued at $232.28. The growing of chicory upon a commercial scale is an industry of some importance.

Dairying and the raising of dairy cattle, beef cattle, horses, sheep, poultry, and mules are well recognized industries and capable of being greatly extended. A limited number of pedigreed horses and dairy cattle of national reputation are produced, but the growing of forage crops and the production of stock upon favorably situated valley and island lands has been greatly neglected.

While more or less unsuccessful attempts are sometimes made to produce upon certain soils crops to which they are not adapted, the principle of the special adaptation of soils, through peculiar chemical, textural, or structural features, to special crops is commonly recognized. Alfalfa is produced chiefly upon the sandy soils of the southeastern part of the area, which is covered by extensive irrigation works. The Peat lands are generally poorly adapted to alfalfa, owing to the close proximity to the surface of the ground water. Some of the clovers and grasses, such as timothy, rye grass, etc., however, here do well. The Peat and Sacramento clay loam, if properly managed, are better adapted to the growing of vegetables, potatoes, and the other special crops produced in this section.

The main public roads are generally improved, and during the dry season good wagon roads cover nearly the whole area. During the rainy season, however, poor natural drainage conditions, with the extremely adhesive nature of the heavy adobe soils, often render the country roads traversing bodies of these soils practically impassable.

A few of the main thoroughfares are turnpiked, and it is upon these few main highways that nearly all wagon traffic is carried on during the rainy season. Upon the delta lands public highways are also sometimes poor or inadequate, but their deficiency is largely met by navigable natural streams or artificial channels. Private roads usually follow the levees.

The area is traversed by two transcontinental railways, while branch lines lead to valley and adjacent foothill points. In addition, river steamers reach nearly all the river landings daily, or at less frequent intervals, offering a cheap and convenient means of shipment of produce to markets, and bringing provisions and other necessary articles from town to the door of the farm dwellings, and in many cases serving as the only means of communication with the outside world. Stockton and San Francisco are reached by steamboat, by sailing vessels, or huge barges in tow of smaller gasoline craft. The river steamer here takes the place of the railroad in performing freight and express service, and at much cheaper rates, while in doing the shopping in local markets and in hauling farm produce to shipping points the private gasoline launch and small barge often perform the work of the ordinary farm vehicles.

Much of the fruit and other produce is shipped by rail direct to eastern markets. Stockton, the county seat and manufacturing center, is a grain and farm produce shipping point of some magnitude, and furnishes a local market for much of the vegetables, truck, and dairy products. Grain, flour, feedstuffs, potatoes, vegetables, wines, and other farm products are shipped in large quantities by water to San Francisco, much eventually finding its way to the newly opened and developing markets of the Orient.

SOIL SURVEY OF ISLAND COUNTY, WASHINGTON.

By **E. P. CARR** and **A. W. MANGUM.**

LOCATION AND BOUNDARIES OF THE AREA.

Island County comprises a group of islands lying in about the center of Puget Sound, between 122° 21′ and 122° 46′ west longitude and between 47° 54′ and 48° 25′ north latitude. It is bounded on the north by Skagit County, on the east by Skagit and Snohomish counties, on the south by Snohomish and Kitsap counties, and on the west by Jefferson County and the strait of San Juan de Fuca. The land area of the county is about 148,992 acres, or 233 square miles.

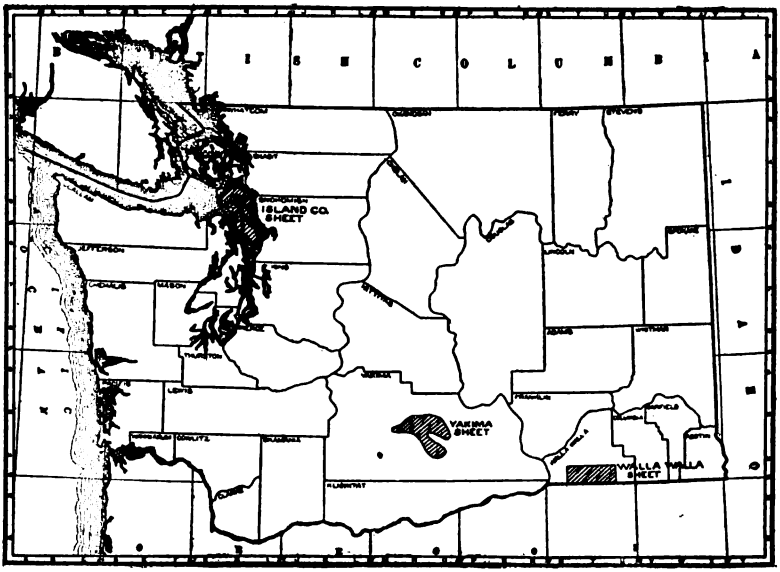


FIG. 44.—Sketch map showing location of the Island County area, Washington.

Whidbey Island is the largest and most important island of the county and of Puget Sound, with a length, north and south, of 35 miles, and varying in width from 1 to 11 miles. Camano Island lies just to the east of Whidbey, and embraces an area about one-fifth as large as the latter. Besides these two main islands, the county includes the very small islands of Deception, Smiths, and Ures, which it was not practicable to show on the map.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The original inhabitants of Island County were a mild-mannered race of Indians that made an easy living fishing and digging clams and growing potatoes and camas bulbs. They have never offered any serious obstacle to the settlement of the islands.

In 1850 Colonel Ebey took up the first donation claim on Whidbey Island, and in the same year other claims were taken up at Oak Harbor. In 1857 Captain Coupe laid out the town of Coupeville, the county seat. Coveland was settled in 1853 and Utsaladdy in 1856. These first settlers took up the choice untimbered black "prairie" lands on the islands, while the extensive uplands were gradually taken up for the sake of the fine timber, and lumbering has been, and is still, the only industry of importance on these upland soils. Fir, cedar, spruce, and hemlock have been removed from considerable tracts of land, yielding from 25,000 to 35,000 feet of lumber per acre. About nine-tenths of the county is still uncleared, and while the choicest timber has been cut on most of the lands, there are still considerable bodies of good fir and cedar. Many tracts have been cut over two or three times, and large sawmills have been operated at Utsaladdy, Coupeville, and other points. There is at present no land in the county subject to homesteading.

In the eighties the railroads opened up the Northwest Territory, and the development of Alaska and of the oriental trade has further stimulated the agriculture of the section in establishing ready markets for the farm produce. Immigrants from Holland and Scandinavia have more recently built up a promising dairy business, and a creamery has been in operation at Crescent Harbor since 1898. The establishment of Fort Casey on Whidbey Island in 1897 served to strengthen the local market for produce.

A serious obstacle to extending the area of cultivated land to the timbered upland soils is the great difficulty in clearing such heavily timbered land. The cost of clearing is estimated at from $85 to $150 an acre on these uplands, an almost prohibitive cost, except for select crops for special markets. The open and more fertile "prairie" areas have largely remained the limited seat of farming operations.

The fisheries are an important economic resource of this county, and several large fish traps along the northern shores of Whidbey Island yield a considerable income from the catches of sockeye salmon and other fish.

Island County was organized January 6, 1853. The population in 1900 was 1,870, and was estimated in 1903 to be 2,618. Coupeville, the county seat, has a population of about 600.

The following tables, Bureau station at Cou tions in this area:

Normal monthl

Month.	Ten ati
	°
January	
February	
March	
April	
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Dat

Year.	La spr
1897	Ma
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1900	Ap

Sheltered from the c clad Cascade Range t environment, Island Co winters are mild and th ing as low as zero or as known to occur during

There is a fairly disti ing from about the 1st is very scanty, and the The snowfall is infreq however, a rather larg weather. Precipitate a marked difference in miles in the county. A except at Coupeville, based on the difference Snohomish County, ma the rainfall at Coupev This is explained by t reference to the Olym laden winds approach generally from the southwest and condense on this range, with a consequent excessive rainfall on the windward or coast side. The central portion of the county, around Coupeville, lies to the leeward of these mountains, and the winds are already deprived of a great part of their moisture before reaching this section. The southern part of the county is not so much sheltered from these winds by the mountains and receives in consequence a higher precipitation.

PHYSIOGRAPHY AND GEOLOGY.

The islands of this county consist for the most part of rolling uplands, varying in elevation from 50 to 150 feet, and rising to an occasional height of 300 feet. Several small areas of open black prairie land are found among the uplands. These constitute the choice farm lands of the area, and represent the beds of former lakes or lagoons. There are about a dozen small fresh-water lakes in the county.

These islands are made up of glacial deposits, and represent the moraines of the glaciers which descended into the Puget Sound basin from the Olympic and the Cascade mountains. These glacial deposits consist of sands, gravel, and clays, showing local stratifications, and mixed with glacial stones and bowlders up to a foot or more in diameter. There are very few bowlders of large size. In topography the glaciated uplands are comparatively uniform and regular, rising to a fairly defined crest or ridge that extends the length of Whidbey Island. Only one or two instances of typical kame and kettle topography was observed. Bowlder clay is generally to be found at a depth of a few feet below the surface, with thin erratic seams rich in lime. These glacial sediments are from 500 to 1,000 feet deep, and overlie the native Eocene rocks of sandstone and shale. The tip of Whidbey Island, at Deception Pass, is the sole instance where the rock outcrops, and here there has been the violent uplift of a small peak of highly metamorphosed sandstone.

The black, level prairie lands in the uplands indicate that they were the floors of former glacial lakes or the beds of brackish lagoons that at one time had outlets into the waters of Puget Sound, but are now at adequate elevations to afford highly productive farm lands. In the beds of these former lakes and lagoons the glacial materials were reworked and redeposited and mixed with a very marked accumulation of peat and other organic matter. Ebeys Prairie and Smiths Prairie are the best instances of such black prairie lands. In certain small depressions in the uplands and among the marshes on the shore organic matter has accumulated to such depth as to form small bogs of peaty soils. These peat areas represent an earlier stage of the same process of humus formation that produced the fer-

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There are no streams
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Ten soil types were en
following table shows th
tion which each type for
tion of these different so
ing this report.

Soil.	Acr
Miami stony sand	71,
Miami gravelly sand	33,
Miami stony sandy loam	25,
Clyde gravelly sandy loam	5,
Peat	4,
Miami clay loam	2,
Clyde sandy loam	1,

The Clyde loam consis
loam, very rich in organi
tled drab and yellow cla
36 inches.

This type is found in s
or near the head of Crock
on Whidbey Island, and
Island, besides in one or t
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row strips along the cou

these coves. The type generally lies at a sufficient elevation above tide water to insure fair drainage, but in no case exceeds an elevation of 40 feet. On account of the rather limited rainfall of this area the low position of this soil is quite to its agricultural advantage, and it stands in notably less need of artificial drainage than would be the case in areas of greater rainfall. At its lowest elevations, however, it is decidedly improved by drainage.

The Clyde loam occupies the beds of former brackish sloughs that emptied into marshes at the head of coves, the waters of which have now so far receded as to leave these beds well above the tide. In these channels the glacial materials were reworked and redeposited and mixed with a marked accumulation of peat mosses and other semiswamp vegetation. The heavy texture of the soil indicates that its location was the lowest plane of such redeposition, where the finer sediments were laid down in comparatively deep water; that is, in the middle of these sloughs or lagoons.

The organic matter mixed with this type in its process of formation has been thoroughly decomposed and incorporated with the soil, incident to its emergence and exposure to the air, and has made it naturally very rich.

This soil is one of the very best in the area for general farm crops, receiving no artificial fertilization and producing large yields year after year. Its heavy texture, combined with its low position, insures a large supply of moisture and makes the type practically exempt from drought. This soil is the best in the area for wheat, yielding from 50 to 80 bushels per acre, while a yield of 117 bushels is on record as the average yield of 10 acres during a good season. The wheat is, however, of a soft-grained variety—the Red Australian—and is not so well adapted to milling as the harder wheats. The yield of potatoes runs from 250 to 500 bushels per acre, and hay yields from 3 to 4 tons. Oats likewise will yield from 40 to 75 bushels, but this type is not so well adapted to oats as is the Puget clay, though, on the other hand, it is much better adapted to wheat than is that type.

A small acreage of this soil is planted to beets, carrots, onions, and sugar beets for stock, and the yield of these root crops runs from 10 to 20 tons, showing the soil well adapted to such crops.

This type is all under cultivation, and has been for years. Its value is reckoned at from $80 to $250 an acre.

The table following shows the average results of mechanical analyses of the soil and subsoil of the Clyde loam.

Mec

Number.	Desc
13161, 13163	Soil
13162, 13164	Sub

CLY

The surface soil of the
to 15 inches of coarse
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long exposure to atmosp

The main crop grown
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and gets the benefit of th
from 150 to 300 bushels
is not so well adapted
because of its leachy sub

from 25 to 40 bushels of soft-grained wheat or oats, and from 1 to 2 tons of hay. Onions, carrots, and sugar beets yield from 5 to 10 tons, but are not planted to any great extent. The soil affords good locations for poultry ranches on account of the ready underdrainage, and in general early garden crops and berries succeed well. The greatest success, however, has been found to be the early potato crop. This type is in pretty general cultivation, the lands being valued at from $40 to $125 an acre.

The following table shows the average results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Clyde gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
13184, 13186	Soil	10.8	31.8	12.7	11.9	4.8	9.6	18.1
13185, 13187	Subsoil	6.6	28.1	27.4	27.7	4.0	2.1	3.9

CLYDE SANDY LOAM.

The surface soil of the Clyde sandy loam consists of about 12 inches of medium black sandy loam, rich in organic matter, and containing some coarse sand and fine gravel. The subsoil, to a depth of 36 inches, consists of a drab or mottled drab and yellow clay loam to clay, containing at times a small proportion of fine gravel. Occasional small glacial stones and cobbles are found scattered through parts of the type.

This type is an intermediate soil between the Clyde loam and the Clyde gravelly sandy loam, possessing the clay subsoil of the former type with the sandy loam surface soil of the latter.

Limited areas of this soil are found on Ebeys Prairie and near Oak Harbor, Crescent Harbor, and the head of Duguala Bay. The topography is level to gently rolling, the areas occupying either the immediate upper margins of the Clyde loam or the lower depressions within the Clyde gravelly sandy loam. Its drainage is in general adequate, and the fairly low position of the soil is an advantage in this climate.

The type has been formed by the accumulation of organic matter in the beds of former swamps or water channels, the glacial materials having been reworked and redeposited in essentially the same manner as in the formation of the Clyde loam.

This soil ranks next to the Clyde loam in its production of wheat and oats, and is practically just as productive as that type for potatoes. The yields of the root crops are high, but the acreage very limited. On account of its heavy subsoil this type is better enabled to withstand drought, and is fitted for the successful growing of wheat,

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Mecha

Number.	Des
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13168, 13170....................	Sub

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and not too rapid growt
of tree.

These lands can be purchased at from $20 to $40 an acre, and offer one of the best opportunities for development in the area, though they are quite limited in extent. Their heavy texture and consequent capacity for storing up the scanty rainfall would prove in the long run one of their best advantages.

The following table shows the average results of mechanical analyses of typical samples of the fine earth of the soil and the subsoil of the Miami clay loam:

Mechanical analyses of Miami clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
13176, 13178	Soil	1.4	7.3	4.4	7.9	11.9	36.8	30.0
13177, 13179	Subsoil	.4	1.7	1.1	3.3	10.3	50.8	32.1

MIAMI GRAVELLY SAND.

The surface soil of the Miami gravelly sand consists of from 12 to 15 inches of gray medium to fine sand or light sandy loam, containing at times a small percentage of coarse sand and fine gravel. The subsoil to a depth of 36 inches consists of loose yellow medium to fine sand, also containing some coarse sand and fine gravel. Both soil and subsoil carry on an average from 10 to 20 per cent of glacial stones and cobbles, but near the crests of ridges the stone content may rise to as high as 50 per cent, embracing some small glacial bowlders.

The main area of this soil is found covering rather uniformly the southern head of Whidbey Island, and a smaller area occurs in the northeast part of Camano Island. In its topography it is fairly to decidedly hilly, forming the upland glacial ridges. In many places the soil would, if cultivated, be somewhat liable to washing, while on account of the loose sandy subsoil it is leachy and suffers easily from drought.

The Miami gravelly sand is of morainic origin, being formed from the glacial débris of mixed sand and stones. It has been but slightly modified by atmospheric weathering, with only an occasional accumulation of a light sandy loam texture in the top soil, and is quite deficient in organic matter.

The type is almost entirely in forests, from which the choicest fir, cedar, spruce, and hemlock have been cut. Only here and there around the small villages is a small acreage devoted to the home garden or to growing berries, early potatoes, and fruit for local markets. Some good early strawberries are raised and shipped in small quantities. Cherries were observed to flourish on this soil, but the trees seem liable to suffer from bark splitting on account of too rapid growth.

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Miami gravelly sand:

Mechanic

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13195, 13197	Sub

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gravel. The subsoil to a
sandy loam to an assort
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and subsoil contain from
small bowlders. This ty
the other upland types—
but with a heavier and
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of Whidbey Island and

The topography of thi
teristic on the less stee
Miami stony sand.

The Miami stony sandy loam has such ready natural drainage that cultivated areas are somewhat liable to washing. The rainfall, however, is as a rule gentle and protracted, thus reducing the damage from this source. The porous subsoil causes in it a tendency to leach, but at the same time offsets in a measure the danger from washing by absorbing the rainfall more readily.

This soil likewise is of morainic origin, but atmospheric weathering and the accumulation of organic matter has been more pronounced than in the cases of Miami stony sand and Miami gravelly sand, while the humus has been better conserved than on the steeper and more eroded slopes of the latter types.

After the Miami clay loam this type ranks better than the other upland types for farming purposes. Nearly all of it, however, is still in forests of fir and cedar, and only occasional and better lying tracts are devoted to grass and potatoes. Largely owing to favorable climatic conditions, red clover makes a fine growth on lands of this type and should furnish the basis for improvement wherever areas are cleared. The soil is too light for wheat and oats, but well adapted to garden crops intended for the midseason market. It should likewise prove adapted to cherries and to the berry crops. Strawberries would seem better adapted to this type than to the lighter soils, which are more subject to drought. The yields of hay average about 2 tons per acre, and of potatoes from 100 to 200 bushels.

Lands composed of the Miami stony sandy loam can be purchased at from $10 to $100 an acre, depending upon the character of timber growth. The partly cleared lands are of course the cheaper ones. Stonier areas of this soil should be kept in forest or utilized for pasturage, white clover being encouraged for this purpose. The better areas will doubtless best pay for the cost of clearing when devoted to truck and berry crops, to which the type is more adapted than to general farming.

The following table gives the average results of mechanical analyses of the fine earth of this type of soil:

Mechanical analyses of Miami stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct*	*Per ct.*	*Per ct.*	*Per ct.*
13188, 13190	Soil	7.1	13.4	6.8	13.8	15.1	25.6	18.0
13189, 13191	Subsoil	9.8	19.4	12.0	19.4	11.2	15.9	12.1

MIAMI STONY SAND.

The surface soil of Miami stony sand consists of 0 to 12 inches of gray medium to coarse light sandy loam, containing a considerable proportion of gravel varying from small pebbles to cobbles 3 or 4 inches in diameter. The sub consists of a mixture of coars gravel. Both soil and subsoil erate sized glacial stones and c while rougher areas may conta

This soil constitutes the mai islands, covering uniformly the pying the flanks and steeper hi and extending down the steep Whidbey Island. Its topogra elevation from the shore-line b in height.

The hilly topography insure cultivated, would in many case coarse gravelly subsoil serves a acter and subject to drought.

The Miami stony sand is of n sands and gravels of the glaci also served to accent its coarse more readily removed by erosi by atmospheric weathering, a

The Miami stony sand is stil tially cut over, the native gro alder bushes and salmon berri locations.

In a few less stony areas ear factory yield, securing the ver den crops might be produced. utilized are devoted mostly readily on this soil and furnis son; this indicates the possibi doubtless not pay on the wh lands for beef cattle and she favor such an industry. A lit the Italian rye grass, redtop, such wet spots. But this soil The more stony areas should b while only the less stony areas ited use for the crops mention

These lands range in value the quantity of standing timb

The following table shows the average results of the mechanical analyses of the fine earth of the Miami stony sand:

Mechanical analyses of Miami stony sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
13180, 13182	Soil	14.8	21.1	13.6	18.2	8.2	13.2	10.6
13181, 13183	Subsoil	11.1	25.8	16.9	28.1	7.6	5.3	4.9

PUGET CLAY.

The surface soil of the Puget clay consists of about 15 inches of drab clay, containing a high percentage of partially decomposed organic matter, which gives to the soil a loamy, silty feel. The subsoil is a bluish-gray silty clay to clay, with a depth of 36 inches or more, containing a small proportion of more or less decomposed organic matter. The type is entirely free from stones and gravel.

This soil is only found as a narrow strip bordering the shallow waters at the northeast end of Camano Island, and at the head of Livingston Bay. Its topography is very flat and low lying, and the cultivated areas are under dike to keep out the high tides and storm floods.

The natural drainage is consequently poor, and the soil must be ditched and underdrained to give satisfactory yields. The open ditches are fairly permanent in this compact soil, and the dikes are themselves efficiently made out of the heavy peaty and clayey materials of the type. In underdraining "blind drains" or box flumes of cedar slabs are generally employed.

This soil is a marsh type, and owes its origin to beds of fine alluvial sediments brought down from the mainland by the Stilaguamish River and laid down in the shallow waters near its mouth as a delta deposit. The areas of this soil lie just opposite the mouth of the river on the mainland. Upon these finer delta deposits has accumulated the more or less decayed growth of salt grass, etc., which adds organic matter and lightens the soil texture. The soil scours readily under the plow, despite its heavy texture, but is liable to bake and crack badly when it becomes dry.

This type is planted almost exclusively to oats and seems remarkably adapted to that crop. The average yield runs from 80 to 100 bushels per acre, and yields of 150 bushels are on record for good seasons. It appears that such parts of the type as are not too high in their content of organic matter, but in which the silt and clay is prominent and has had a chance to weather by exposure to the air, produce the largest yields. Yields of 3 to 4 tons per acre of timothy

and red clover hay are a
a tendency to scab.

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yields of oats secured,
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The lands composed
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The following table gi
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Number.	De
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13173, 13175	Su

No. 13172, loss on ignition, 12.8 p

The Peat consists of
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This soil has been for
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rated from the waters
spit of sand and gravel
has occurred the accu
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some 10 feet above, an
ditions than were ope
The small inland bogs
higher elevation.

The organic matter in this type is by no means so thoroughly decomposed as in the Clyde loam, owing to lack of drainage and of exposure to the air. The soil is consequently more apt to be acid and in greater need of a neutralizer, such as lime or potash.

The Peat is at present used, if at all, merely for pasture and a little hay; but the soil, when properly drained, is especially adapted to celery, onions, and cranberries, and should be devoted to these crops. There appears to be the chance here to turn these lands to a much larger profit by growing these special crops, with the right attention to the question of drainage.

GALVESTON COARSE SAND.

This type consists of 36 inches or more of medium to coarse sand, with a mixture of fine to coarse gravel, shell fragments, etc. It occurs as a narrow fringe at the foot of the bluffs around the shore lines of the islands, but only the fairly prominent areas, consisting of sand spits and of beach lines along the concave shores of bays and inlets, have been indicated on the map.

The Galveston coarse sand has been formed by the action of waves along the more open beaches. It has no agricultural value and at present no apparent possibility.

The following table gives the results of a mechanical analysis of a single sample of the Galveston coarse sand:

Mechanical analysis of Galveston coarse sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
13171	Soil	2.6	52.9	41.1	2.7	0.0	Trace.	0.4

ROCK OUTCROP.

In the extreme northern end of the survey occurs a small area which has been designated on the map as Rock outcrop. The outcrops of many stones and small bowlders and the generally rough topography render this area of little or no value for agricultural purposes.

AGRICULTURAL METHODS.

The agricultural methods employed in different parts of the area are quite well adapted to the respective soils, and the high cost of labor has encouraged the general use of improved farm machinery.

Potatoes are the chief crop of Island County, and, while the plants are entirely free from potato bugs, there is a tendency to scab. This tendency is doubtless favored by the presence of some salt in the low-lying and marshy areas, and in some parts of the uplands by a notice-

able occurrence of lime in sean
also very liable to produce scal
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beginning to be practiced, and
also somewhat subject to potat

Wheat and oats are planted
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plant very early in the season.

Timothy and clover are grow
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On the lighter upland soils t
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under such conditions.

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toes, and hay is practiced more
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should be introduced regularly
give more body to these thin s

AGRICULTURAL CONDITIONS.

The farmers of the county are at present in a prosperous condition, most of them being located on the rich prairie lands to which farming is as yet largely confined in this area. There are practically no mortgages on farming lands, and the majority of the farmers live well and enjoy some luxuries. The general financial condition of the farming class has decidedly improved in the last ten years, with the rapid growth of the cities on the Sound and the demand for farm produce created by the Alaskan trade. The dwellings are on the whole commodious, with large, well-appointed barns, and the farms wire-fenced.

Practically all the farmers in the county own the farms they operate, but a small acreage is rented to Chinamen for growing potatoes, and some farmers rent cleared lands to operate in addition to what they own. When lands are rented, a cash rental of $8 to $14 an acre is asked, the average being about $10. In general only high-grade lands are rented, and the owner secures in addition the contract to furnish teams to work the crop and do the hauling. Very little land is farmed on shares, the owner usually getting one-third of the produce under such arrangements.

The average size of the farms in the county, according to the Twelfth Census, is 121 acres. Many of the prairie farms are larger, but none exceeds 320 acres. The farms on the uplands are much smaller, and as a rule only from 10 to 20 acres have been cleared on these upland soils, the balance of the farm land being still in timber. The prairie lands are altogether under cultivation.

Labor is usually scarce during harvest time, but plentiful at other seasons of the year. This labor consists almost entirely of white laborers, although a few Indians are sometimes used about the farm. The Chinaman generally farms in the capacity of a renter for cash. When hired by the day during the harvest season, the wages are from $1.50 to $2 a day; when hired by the month, from $28 to $35 is paid, with board in addition.

The principal agricultural products are, first, potatoes, then wheat, oats, hay, and dairy produce. The quantity of fruit, berries, and poultry produced is small, but the acreage devoted to these products is on the increase, since most of the uncleared lands can be used for these purposes, and the market is good.

The lumbering and fishing industries have already been mentioned as important interests of the county. A few sheep and beef cattle are raised, but the possibilities of the industries are not yet even entered upon. Fairly good grades of Guernsey and Jersey cows are kept by the dairymen.

There is a rather specific recognition of the adaptation of crops to the soils in the area, as is to be more or less expected where soils of such opposing texture are encountered. For example, the Puget clay is devoted almost exclusively to oats, or to oats with timothy and clover, and it would be difficult to suggest a more remunerative crop for this type of soil. The Clyde loam and Clyde sandy loam are used for wheat, potatoes, and timothy hay, and here again the adaptation could hardly be improved upon. The upland soils, again, where cleared and cultivated, are devoted mostly to garden and berry crops, and the lumbered portions more to pasture, and this is in a line both with business expediency and with the natural adaptation of these soil types. There thus arises a very fair specialization in farm products, for the reason that there are found certain sharply defined open areas of tide land and prairie land that are eminently adapted to oats, and to wheat and hay, and it is hopeless to undertake the formidable and costly task of clearing the lighter and stonier upland soils to compete with these in such staple products.

There is no railroad in Island County, and transportation is by boat and team. No part of the county is more than a few miles from some local wharf, and the small steamboats afford cheap and ready transportation for the farm produce. The county roads around Coupeville and in the central part of Whidbey Island are surfaced with gravel and are exceptionally good, and in general the county roads, even where unimproved, are very fair when the stones are removed. There is, however, need for extension of the road system in the lower and upper parts of Whidbey Island and on Camano Island.

The principal markets for the products of the county are Seattle and Everett. The market at Seattle affords an unlimited demand, with good prices. The lumber and mining companies obtain their supplies at Seattle, and this, coupled with the Alaskan demand and the supplies purchased by the United States Government at that point, maintains a fine market there. The creamery at Oakharbor offers a ready disposal for such dairy products as are not shipped to Seattle and Everett.

SOIL SURVEY OF THE EV

By E. P. CARR

LOCATION AND BOU

Snohomish County lies in the
the eastern shore of Puget Sounc
survey comprises the western p
within parallels 47° 46′ and 48
122° and 122° 24′ west longitude
by Skagit County, on the east by
the south by King County, anc
contains 336,064 acres, or about 5
fifth of the area of the county,
fifths being very mountainous an

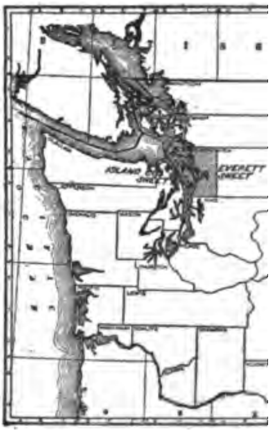

FIG. 45.—Sketch map showing loc

HISTORY OF SETTLEMENT AN

Snohomish County was first e
Whidbey Island and Port Town
along the Snohomish River. Th
a mild-mannered race of Indian
whose present home is the Tula
part of the area. In January,

when the railroads were built in 1888 this part of the county developed with wonderful rapidity. The city of Everett, now the county seat, grew from a population of none in 1891 to 20,000 in 1902. The rural sections, however, are as yet largely unsettled, with the exception of the valley lands along the rivers and the delta lands at their mouths, and most of the area is to-day still in imposing forests of fir, hemlock, and cedar, or but recently logged off.

Lumbering is the chief industry of the county, and Everett one of the first of log markets. The total annual output of lumber products is valued at over $8,000,000.

The farming population comprises many different nationalities, but there is a preponderance of Scandinavians and Germans. The agricultural development of the area has been chiefly along the line of general farming, the important products being hay, oats, and potatoes, and along the more special lines of dairying, poultry raising, and berry growing. The valley and delta lands afford the very best of soils for oats, and their yields of hay are large and of fair quality, while the upland soils produce good yields of first quality potatoes.

A majority of the farmers in the area have found in dairying their best success. The heavy valley soils are naturally well adapted to this industry, and on the lighter and sandier uplands there occur here and there local moist depressions and loamy bottoms, which the dairyman has found it profitable to clear for hay and pasture. There are convenient creameries in many of the small towns, the demand for the produce is steady, and the industry is on a substantial business basis.

In several localities poultry raising has proven uniformly successful, and the good demand renders this one of the surest and most profitable forms of intensive farming on a small scale.

In recent years small-fruit culture has become an important industry in the area, and the prospects for this line of special farming are very bright. On the sandier and better drained valley soils choice crops of raspberries, blackberries, and dewberries are grown with very high yields, and these crops command a ready market. The Snohomish and Monroe Fruit Growers' Association was organized in 1903 and has been very successful in placing this industry on a firm business footing. The growing of other fruits, especially of apples, cherries, pears, and choice plums, is open to decided encouragement, although the industry is at present commercially in an undeveloped condition.

The Snohomish County Horticultural Society was established in 1900, and the office of county horticultural inspector has been in exercise since 1896. To the latter office the author is indebted for the courtesy of considerable information as to local agricultural conditions. The Everett Ch instrumental in forwardi of the county.

Since most of the soils uplands, are either heav timber, the greatest draw this section, and the mos settlers, is the cost of clea size of the fir and cedar stu $100 to $200 an acre, in gen extensive farming. For this specialized and intensive fa condition of its future devel however, that this cost of clea of all farm lands in this part intrinsic value, and that there a the country with which one m Moreover, the instances of inte dairying, poultry raising, and b management this investment ca profits.

CLI

The following tables from the r tions at Silvana, Snohomish, and G ence in the rainfall at different poi 20 inches. This difference is, how influence of the neighboring mountai

The rain-bringing winds generall and condense upon the Olympic Mou Snohomish County is so sheltered by already deprived of a large part of this section. The low precipitation a influence. The higher precipitation a outside the area, is doubtless due to the of the area lies to the windward of th again subject the winds from the southw

It is evident from these monthly tables dry season during June, July, August, an known as the rainy season on account of th

The tables showing the dates of killing season of about one hundred and seventy season coincides largely with the dry sea taken into account in adjusting the farmi ditions.

As the climate of this area is of so much agricultural importance, it is necessary to go into some detail on the point. The area is sheltered from continental blizzards by the lofty Cascade Range, and its climate is further modified by its location on Puget Sound. The result is an equable marine climate, with cool summers and mild winters. The thermometer rarely reaches as high as 90° F. or as low as 20° F. There is, however, except in midsummer, a rather large proportion of foggy and overcast weather. Snows in winter are very infrequent and thunderstorms in summer are almost unknown.

It is well to summarize here the influence of these peculiar climatic conditions upon the character of the agricultural products. This cool and on the whole rather moist climate is well adapted to growing grass, although the curing of hay is somewhat uncertain. A specific climatic influence is seen in the different success in growing wheat and oats. The wheat produced is too soft for milling purposes, and is used mostly for chicken feed, while the cool, moist conditions favor the production of unsurpassed oats, which do not require the maturity of hard kernels for milling. Again, the climate is too cool to mature corn to the best advantage, or to color and mature choice peaches; while on the other hand it favors the production of berries of much firmer shipping quality than warmer localities, and is adapted to the growing of hops and cauliflower. Other details of climatic influences will be brought out in other parts of the report.

Normal monthly and annual temperature and precipitation.

Month.	Silvana.		Snohomish.		Granite Falls.
	Temperature.	Precipitation.	Temperature.	Precipitation.	Precipitation.
	°F.	*In.*	*°F.*	*In.*	*In.*
January	36.9	4.56	39.0	5.03	4.32
February	40.0	5.18	41.7	5.55	5.33
March	41.0	3.51	43.7	4.42	6.91
April	47.2	3.57	49.7	3.80	5.36
May	53.5	3.44	55.6	3.77	5.00
June	57.5	1.82	59.5	2.58	4.46
July	60.5	.82	62.8	1.21	2.02
August	61.2	1.27	62.8	1.00	1.87
September	55.2	1.76	57.0	3.12	3.96
October	50.3	2.48	51.5	3.83	5.14
November	42.2	4.62	44.1	6.06	6.27
December	38.0	4.40	40.7	6.27	8.75
Year	48.6	37.43	50.7	46.64	59.39

Dates of first and last killing frosts.

Year.	Silvana.		Snohomish.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1897	....	....	Apr. 27	Nov. 27
1898	Apr. 4	Oct. 8	Mar. 21	Oct. 8
1899	May 15	Oct. 12	Apr. 12	Oct. 13
1900	Apr. 27	Sept. 26	Apr. 26	Sept. 24
1901	May 10	Sept. 30	July 12	Sept. 29
1902	Apr. 24	Oct. 23	Apr. 13	Oct. 22
1903	Apr. 28	Oct. 14	Apr. 10	Nov. 10
Average	Apr. 28	Oct. 9	Apr. 26	Oct. 19

PHYSIOGRAPHY AND GEOLOGY.

This area may be conveniently divided into three physiographic divisions: First, the valley region along the Snohomish and Stilaguamish rivers, including the delta lands at their mouths; second, the rolling hills and benches that make up the bulk of the area; and third, the mountainous uplands that extend with a well-defined bend around the northeastern corner of the map.

The valley region comprises the alluvial bottom lands along the Snohomish and Stilaguamish rivers, and their tributary creeks, together with the delta "flats" at the mouths of these rivers. These valleys attain a width of from 1 to 2 miles in their lower courses, and most of these lands do not exceed an elevation of 20 feet. The immediate banks of these streams have been built up by deposits of fine sand, giving the Puget silt loam, while the lower bottoms farther back from the streams represent the finer deposits of silt and clay, giving rise to the Puget clay. Some parts of these bottoms are so low, wet, and subject to overflow that they form areas of muck or of swamp. The delta flats at the mouths of the rivers have been formed by deposition of these finer materials, silts and clays, reworked by tidal action and modified by marsh growths. These two valley soils are the most valuable in the area.

The second physiographic division embraces the lower hills and bench lands, from 25 to 600 feet in elevation, constituting the majority of the upland area. These hills are in general of easy slope, with more or less flat tops, and are built up of glacial deposits of sand, clay, and gravel. They are a part of the well-defined morainic area that lies between the foothills of the Cascade Mountains and the waters of Puget Sound. The characteristic soil of this region is the Miami sandy loam, while the Miami gravelly sandy loam is a type representative of the coarser deposits of sand and gravel. Deposits of bowlder clay are generally to be found at no considerable depth throughout this region, and the Snohomish silt loam is formed where the material comes sufficiently close to the surface or where it has been exposed by erosion. Only an occasional small kettle hole is to be seen, while but few glacial erratics or bowlders of any large size are found. In fact, these glacial hills seem to show the results of a rather uniform and moderate ice action, or of having been extensively modified by glacial floods and subsequent stream action on a large scale. This is indicated by the terraces along many of the streams and by the extensive bench lands extending from the streams well up the flanks of the hills. The Snohomish fine sandy loam, as well as the Snohomish silt loam, is fairly characteristic of such bench lands and terraces. This region is still but little used for agriculture, and is composed largely of land in heavy forests of fir and cedar or of land from which the timber has been removed. A number of lakes of glacial origin are scattered through this section of the area, Lake Stevens and Lake Goodwin being the largest among them.

The third physiographic division consists of the mountainous uplands in the northeastern corner of the area, rising from an elevation of about 400 up to 1,800 feet. This region is separated from the lower hills and benches by an abrupt escarpment along its whole western border at its base. While likewise subjected to glaciation, it shows frequent and extensive outcroppings of diorite, granite, and schists, and the soils are influenced by the residual weathering of these rocks.

Its characteristic soil is the Miami stony loam, and it is almost entirely uncleared. The geology of this mountainous region differs greatly from that of the rest of the area. Its backbone of igneous rocks (diorite and granite) is of earliest geological age, and contains various ore-bearing seams, intrusions, etc.

On the other hand, the remainder of the area has a geological foundation of sedimentary shales, sandstones, and conglomerates of Tertiary and Eocene age, which have been thrown into folds, and which outcrop occasionally along some of the streams. These sedimentary formations of the Puget Sound Basin underwent a subsidence by which the tilted shales and sandstones were sunk below sea level, the rivers drowned, and Puget Sound formed.

Later still, glacial sediments from 500 to 1,000 feet deep, consisting of plains of till with local deposits of stratified sand, clay, and gravel covered this portion of the area, while the mountainous uplands were to a less degree likewise subjected to ice activity.

The area, as a whole, is well watered, the main drainage being by the north and south forks of the Stilaguamish River, which converge at Arlington, and flow westward into the sound at Stanwood, and by the Skokomish and Snoqualmie rivers, which converge just inside the area, below Monroe, to form the Snohomish River, flowing thence in a northwesterly direction into the sound above Everett.

The Snohomish River flows with an easy fall, and is navigable with small steamers throughout its course in the area, while the Stilaguamish River develops frequent small shoals, especially above the junction of its north and south forks as the mountainous uplands are approached.

SOILS.

Eleven types of soil, exclusive of Swamp, were encountered in this area. The following table shows the acreage of these types and the proportion which each one forms of the total area surveyed:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Miami sandy loam	184,320	54.8	Snohomish fine sandy loam	9,728	2.9
Puget clay	25,792	7.6	Puget silt loam	8,448	2.5
Miami stony loam	23,488	7.0	Swamp	6,080	1.8
Miami gravelly sandy loam	23,360	7.0	Puget fine sandy loam	4,928	1.5
Snohomish sand	21,504	6.4	Galveston coarse sand	256	.1
Snohomish silt loam	16,192	4.8	Total	336,064	
Muck	11,968	3.6			

GALVESTON COARSE SAND.

The Galveston coarse sand soil type consists of 3 feet or more of medium to coarse loose gray sand, containing gravel of various sizes. Its extent in the area is so limited that it is indicated on the map merely for the sake of completeness. It is confined to a few small sandy spits and beaches along the shore of Puget Sound, formed by the action of the waves, and possesses no agricultural value.

The following table shows the results of a mechanical analysis of a typical sample of the Galveston coarse sand.

Mechanical analyses of Galveston coarse sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14064	Soil	2.2	33.3	51.5	12.2	0.1	0.4	0.3

MUCK.

Muck consists of vegetable mold in a more or less decomposed condition, mixed with silt or other earth, and extending to a depth of from 1 to 3 or more feet.

The main bodies of this soil are found along the Snohomish River, between Everett and Snohomish, and southeast of Snohomish. Smaller areas are found here and there along most of the smaller streams throughout the area and around many of the small lakes, while other larger tracts are found in the uplands east of Edgecomb, southwest of Silvana, and west of Bryant.

The topography of the Muck areas is very low and flat. They consist of the lowest depressions along streams which are subject to overflow and of upland bogs. The drainage is very poor or wholly lacking, and artificial drainage is necessary on a systematic and extensive scale to make these tracts fit for cultivation.

The soil owes its origin to the decomposition of peat and other organic matter that has accumulated to a marked depth in these wet depressions. These lands are locally spoken of as "beaver dam lands," and the beavers have doubtless flooded small areas by means of their dams and rendered them wet and mucky; but this action of beavers was rather an accompaniment of the naturally wet and swampy conditions than the cause of them. The type has been formed either in depressions kept wet by overflow from the streams, or where glacial interference has blocked the established drainage with the consequent formation of upland bogs, much in the manner of the more pronounced formation of glacial lakes. The margins of lakes are frequently of this soil type.

When properly drained the Muck is especially adapted to the growing of celery, and some good crops were seen on a few patches of the type. It is also especially adapted to cranberry culture in cases where sand is at hand to "sand" the bogs. The demand for both these products is very active. Cabbage and onions likewise do well on drained areas, while the acid conditions induced by the rich organic content encourages the growth of potatoes free from scab.

At present the Muck is but little cultivated, and much of it is in a semiswampy condition. It is utilized mostly for pasture, where cleared, and on the light sandy uplands it proves a very valuable soil to the dairymen for pasturage. Some small portions of it that are better drained are cultivated in oats and hay. The yield of oats is good, ranging from 50 to 75 bushels, but hay, while the yield is very heavy, is said to be coarse in quality and mixed with a variety of wild grasses.

This type is extremely variable in value, depending largely upon the conditions as regards drainage, etc. Some of it is at present practically worthless, while other tracts bring fancy prices in localities where the acreage of other soils suitable for pasturage is very limited.

Cedar and alder are characteristic growths on the Muck, for which reason it is sometimes loosely spoken of as "alder bottom land."

One or two small areas of salt marsh along the shore of Puget Sound, with a similar mucky texture, are placed with this type.

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This type is derived f
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sandy loam. But in ot

depressions between the upland ridges, and on the flatter bench lands, where the drainage is not so ready and where fires have not occurred, the organic content is quite high from the accumulation of forest litter and the remains of the ferns that grow in rank profusion under the moister conditions. In these cases the soil tends to become a heavier black sandy loam.

On the whole, the Miami sandy loam is too light for general farming, and would prove too costly to clear for growing such staple crops as oats and hay. It is adapted rather to intensive truck and fruit farming, especially where an early market is prized above heavy yields. It is well suited to growing early potatoes, and very profitable yields of 150 to 250 bushels per acre are reported. A few small tracts are planted to strawberries and during favorable seasons produce early crops of good quality and yield. They are, however, somewhat liable to suffer from drought during June and July. The growth of red clover is also surprisingly strong for such a light soil, and is influenced by the cool climatic conditions during the growing season. The presence of occasional seams of impure lime throughout the type indicates another favorable condition for the growth of clover.

On account of the wide variation in its moisture supply, the agricultural value of this soil is quite variable and it is difficult to compute characteristic yields, especially since less than 1 per cent of the type is under cultivation and its possibilities are at present almost entirely undeveloped. This variation in its moisture supply is due to differences in topographic position rather than to variation in soil texture, as well as to the changes in its content of organic matter attendant upon the topographic differences. For example, the lowland areas, either bottoms along streams or depressions that serve to catch the seepage from the adjacent hills, possess a different agricultural value from the steeper hillsides. This is especially noticeable in this area because of the moderate annual rainfall and of the dry growing season. These moister lowlands are in a measure adapted to general farming, and are used to some extent for dairying, whereas the thin and poorly watered hillsides have not a sufficient moisture supply to support crops during a long growing season, and would require some irrigation. In some localities this is practicable by pumping from streams or some of the upland lakes. The safest recommendation for this type of soil would be to devote a very limited acreage to early market crops, potatoes, vegetables, and fruit, with, if possible, means for an occasional irrigation and to make full use of the growth of clover to enrich it with humus, and so increase its moisture supply.

Lands of this type of soil range in value from $10 to $100 an acre, according to location, amount of standing timber, etc., and some of it is at present so inaccessible that the agricultural value can be only

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The following table sh
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Mechanical

Number.	Description.	Fi gra
		Per c
14085, 14087	Soil	
14086, 14088	Subsoil	

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The surface soil of the
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The subsoil consists of 1
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The topography is lev
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loam on the other. It o
types near streams have b
but not to such a degree
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heavy forests of fir, ced
its area.

The Snohomish fine s
truck, or crops for such
is more to be considered

yielding 200 to 300 bushels per acre, but not for the earliest markets. Some of the lower lying and better watered areas are also available for general farming, and would give fair yields of oats and wheat, while clover makes a uniform strong growth. This soil should prove adapted to strawberries, giving surer yields but probably somewhat later crops than the Miami sandy loam.

Some small but vigorous orchards were observed on this soil, and it seems to be well adapted to fruit trees. It is, however, a question of business how far it will pay to clear these lands to devote them to such moderate yields of the staple crops as are commensurate with its moderate moisture capacity.

Not 5 per cent of the Snohomish fine sandy loam is as yet under cultivation. The price of this land ranges from $15 an acre for such of it from which the timber has been removed up to much higher figures, depending upon the character of the forest growth.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of the Snohomish fine sandy loam:

Mechanical analyses of Snohomish fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14091, 14093	Soil	1.8	6.4	4.7	18.9	22.4	32.5	12.9
14092, 14094	Subsoil	1.0	4.4	4.0	12.9	17.4	44.2	15.8

SNOHOMISH SAND.

The surface soil of the Snohomish sand consists of 0 to 15 inches of brown medium sand, overlying a subsoil of gray to greenish-yellow loose sand extending to a depth of 3 feet or more. Both soil and subsoil are largely free from gravel and stones.

The type occupies a characteristic position in a well-defined plain extending between Marysville and Arlington and covering the upper terraces of the Stilaguamish River to the northward around Arlington.

In topography it is flat and fairly level, rising with a gentle incline from tide water at Marysville to an elevation of 150 to 200 feet northeast of Arlington. The drainage is in general adequate on account of the easy fall and loose open texture, and since the wetter areas within this body of soil are represented by other types.

The position of the Snohomish sand and its uniform texture indicate more uniform conditions of glacial deposition, while the character of the inland plain between Marysville and Arlington is such as to evidence the probable course of the post-Glacial floods that swept down the Stilaguamish River and sought here another outlet. Over this inland plain and along the rather extensive upper terraces formed around the confluence of the two forks of the Stilaguamish the Snohomish sand has been laid down in a nearly continuous body.

The forests once covering this soil have largely been removed, though some portions of the type are still occupied by forests of fir and cedar. Little of the area has been cleared for agricultural purposes. The quantity of organic matter in the soil is very variable, the lands that have been burned showing a much lower humus content than the forested areas, which are generally quite rich in this constituent. The soil is rather poorly watered, and its light texture would make it subject to drought.

Considerably less than 1 per cent of this type is devoted to crops. Only an occasional small garden patch or orchard was to be noted upon it. The soil is entirely too light for general farming, the loose and leachy subsoil furnishing a poor moisture supply. There could be little chance for profit in these lands to devote them to oats, hay, or general farm crops, considering the very light yields. The soil is, however, the very model of some of the eastern truck soils, and would, under suitable conditions, be a typical early truck soil. It is adapted to the earliest crops of potatoes, and satisfactory yields of this crop are obtained. It should likewise prove well adapted to very early crops of the other vegetables, if advantage is taken of the good growth of clover it gives to enrich the soil with humus and so insure an adequate water supply for the short growing season demanded by such crops. This would involve a very intensive system of farming, on say 3 to 10 acres, with special reference to early markets, and the extra prices on the early crops should justify an expenditure for fertilizers to maintain or increase the productiveness of this light soil.

The lumbered areas of this type are valued at from $10 to $25 an acre, while timbered tracts may of course run much higher.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Snohomish sand:

Mechanical analyses of Snohomish sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14079, 14081	Soil	2.6	19.2	17.3	34.8	11.1	8.2	6.7
14080, 14082	Subsoil	1.7	16.6	17.7	40.3	13.4	5.9	4.1

MIAMI GRAVELLY SANDY LOAM.

The surface soil of the Miami gravelly sandy loam consists of 0 to 10 inches of medium to coarse brown light sandy loam, overlying a subsoil of yellow to gray medium to coarse sand, extending to a depth of 3 feet or more. Both soil and subsoil contain from 25 to 50 per cent of medium to coarse gravel, while occasional larger stones and small bowlders are present.

This soil occurs in scattered areas throughout the greater part of the uplands; for example, north of Snohomish, east of Edmonds, west of Marysville, and south of Florence, and occupies a well-defined belt separating the higher terraces from the bottom lands of the Stilaguamish River about Arlington.

In its topography it varies from nearly level, along streams and about the margins of lakes, to very hilly on the steeper slopes of the upland ridges, the areas nowhere exceeding an elevation of 600 feet. The drainage is rapid and in many areas excessive, and the coarse texture of the subsoil affords perfect underdrainage, serving to increase the tendency of this soil to leach. It is too subject to drought to insure regular crops under average conditions.

The type owes its formation to coarser glacial deposits of sand and gravel throughout the uplands, or to the coarser sediments laid down about the margins of lakes and along streams that were at one time more pronounced channels of glacial floods. Along these stream courses are found at times irregular beds of compact gravel, while the gravel content may also occur in more or less compact but erratic bands throughout the upland areas. These lands are practically wholly uncultivated, and have either been lumbered or are covered by forests of fir, with some cedar in a few of the loamier hollows. The accumulation of organic matter is thin, and has been retarded by erosion on the hillsides and by the coarse and porous texture of the soil.

The Miami gravelly sandy loam is in general too light and leachy for general farming, although some of the better watered bottoms could be utilized for hay and pasture. Except under such special conditions as regards seepage or the presence of streams the type is liable to suffer seriously from drought before the close of the growing season. It is doubtful if this soil could be put to better use than to forestry.

Under favorable conditions the soil can be used in the growing of potatoes and truck for the earliest market, and fruit trees would be well worthy of trial if due attention were given to getting the trees properly started. Some means of irrigation would be necessary, however, to insure success even with the earliest crops, and provision should be made for the use of fertilizers for such crops, especially after the first few years. High prices would have to be relied upon to compensate for light yields. Fair yields of very early potatoes are reported for this type in favorable seasons, but its agricultural possibilities are almost wholly undetermined.

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sandy loam:

Mechanical a

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14101, 14103	Soil	
14102, 14104	Subsoil	

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escarpment separating
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second, the modification of this residual product by an overlay of glacial deposits composed largely of these same igneous materials in comminuted form. There occur, therefore, rounded gravel and glacial cobbles in such deposits, and also, wherever the ice had an abrading action or where erosion has been more pronounced, areas of angular stone fragments or of bed rock. The western escarpment shows in many places extensive exposures of the bed rock.

This soil is still almost entirely in forests of cedar, hemlock, and fir, and scarcely at all cultivated. There are no farms now upon it, but only here and there a patch of fruit or vegetables around some lumberman's hut. The texture of this type is, however, such as to adapt it to general farming and to fruit, and in many cases the stone content is such as not to impede cultivation. The climatic conditions vary considerably at the different elevations and the resulting influences on crops are undetermined. It is impracticable to assign yields to a soil so little of which is cultivated, but, judged by its texture and content of organic matter, it has decided agricultural possibilities for growing oats, grass, potatoes, and wheat, and next to the Snohomish silt loam the less stony tracts of this type constitute the best uplands in the area. The bodies of this type are still very inaccessible.

The land of this type of soil is valued largely according to the character of the standing timber.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Miami stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14105, 14107	Soil	4.4	7.2	3.5	9.1	12.4	43.7	19.6
14106, 14108	Subsoil	4.0	9.4	4.7	13.6	16.4	37.0	14.8

SNOHOMISH SILT LOAM.

The surface soil of the Snohomish silt loam consists of 0 to 12 inches of reddish-brown light silty loam, overlying a subsoil of yellow or drab silt loam to silty clay extending to a depth of 3 feet or more.

The chief developments of this soil are southeast of Snohomish and near Monroe, between Hartford Junction and Jorden, along Jim Creek, and around Cedarhome.

Its topography is level or gently rolling, and it occupies chiefly lower river terraces or bench lands near the streams, not exceeding

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improvements, etc.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Snohomish silt loam.

Number.	Description.	Fine gravel	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14095, 14097	Soil	1.3	4.0	2.4	5.3	8.3	60.2	18.0
14096, 14098	Subsoil	.5	2.5	1.7	5.4	10.3	53.2	26.2

PUGET SILT LOAM.

The surface soil of this type consists of 0 to 15 inches of light silty loam of drab color, while the subsoil consists of from 15 to 36 inches or more of a drab to yellow compact fine silty sand.

The type occurs as the immediate banks or narrow first bottoms along the greater part of the courses of the Snohomish and Stilaguamish rivers and of Pilchuck Creek, but disappears as the delta lands are reached, and also as these valleys become narrower in their upper courses. Its topography is nearly level and rather low, not exceeding at any point an elevation of 20 feet above the contiguous stream. The contour of its surface rises away from the streams with a very gentle incline to the lower level of the heavier second bottoms of Puget clay.

Because of this characteristic easy slope and of the sandy subsoil. the drainage of this soil is excellent, while nevertheless the relative slight depth to the water table in a large measure insures the crops against drought.

The Puget silt loam has been formed by the deposition of coarser, sandier materials in narrow bands along the banks of the streams, indicating deposition by swifter currents. The immediate margins of these banks are in fact quite sandy throughout their profile, but pass into a silty loam within a distance of a few feet.

On account of the gentle rise in its position this bottom soil has not sustained any accumulation of organic matter under swampy conditions, and the organic content is much lower than in the Puget clay.

The type, on account of its well-watered position, is fairly well adapted to general farming; while it is especially adapted, on account of its light texture and adequate drainage, to the production of earlier crops of vegetables, potatoes, and berries, and to hops.

Oats yield from 75 to 100 bushels, and hay from 2½ to 3½ tons at a cutting per acre. Potatoes yield from 300 to 400 bushels of good quality. This type of soil has been used near Silvana and Monroe for growing hops. From 1 to 1¼ tons per acre of prime quality are usually secured, but the industry has languished because of uncertain intermediate in its texture between the Puget clay and the Snohomish sand, and it has been formed where marginal areas of the latter type along or near streams have been so modified by the lowland conditions and the accumulation of the remains of water-loving vegetation that its surface has been given a heavier texture, or where wet areas of Puget clay have passed into the higher-lying Snohomish sand with an easy gradation of such extent as to warrant an intermediate type between the two. A characteristic feature in the type is its position at the foot of the upland ridges that bound the plain of Snohomish sand between Marysville and Arlington, where the seepage from these ridges has gathered into narrow depressions or given rise to the formation of small stream courses.

The surface soil is fairly rich in organic matter in a well-decomposed state, but is lower in its organic content than the Puget clay. The most of the cleared area of this soil is devoted to pasturage, while areas used for grass, Alsike clover, and Italian rye grass give yields of 4 or 5 tons of hay per acre. Oats are also grown on some areas, yielding from 40 to 70 bushels per acre. On account of its poor drainage, pasturage is doubtless the safest use to which the soil can at present be put, while oats and hay are best adapted to the better drained areas. If properly drained the soil is adapted to growing celery, cabbage, onions, and potatoes.

The Puget fine sandy loam land has a value of from $50 to $150 an acre.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Puget fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14065, 14067	Soil	0.3	2.5	2.5	20.2	15.8	37.4	21.1
14066, 14068	Subsoil	2.4	18.9	16.2	32.7	12.7	11.3	5.7

PUGET CLAY.

The Puget clay consists of 0 to 18 inches of drab, heavy silt loam or silty clay, generally rich in organic matter, overlying a subsoil of drab or mottled blue and yellow silty clay which reaches a depth of 36 inches or more. The soil contains from 10 to 15 per cent of undecomposed organic matter which, with the large silt content, gives it a silty feel. As this organic matter decomposes the soil will become closer and heavier.

The type is located along the courses of the Snohomish and Stilaguamish rivers, and some of the larger tributary creeks, and spreads out in the shape of a delta fan around Stanwood, at the mouth of the

Stilaguamish River and at the mouth of the Snohomish above Everett.

It is low lying and the topography is flat. It occupies the position either of alluvial lower or second bottoms, or of delta tidal flats. On account of its low position the soil is uniformly in need of artificial drainage, and in most cases can not be cultivated until it is drained. Parts of these lower bottom lands are subject to overflow, or require to be protected by dikes, while considerable areas of the delta flats are under dike to keep out the high tides and freshets. Very efficient dikes are made out of this heavy soil, especially where peat is incorporated with it, and plans are on foot to reclaim other tracts now in a swampy condition by means of them. Drainage is generally effected by open ditches, while flume outlets with head gates, to be opened at ebb tide, are necessary on such diked lands as are below the level of high tide. Underdrainage is to be recommended for more general use on these soils, either by tiles, or by the use of cedar boards, which are said to give good service.

Puget clay owes its origin to the deposition of fine materials under quiet conditions back from the main currents of the rivers and over the broad deltas at their mouths. In the case of these delta flats the deposits have been somewhat reworked and spread out by the tides, while the salt water has doubtless also served to precipitate the suspended silts and clays brought down by the rivers.

The surface soil is generally very rich in organic matter in a more or less decomposed state, due to the accumulation of the remains of swamp vegetation. In some of the lowest lying areas the accumulation of peat, etc., has been so marked that the soil has changed into muck. Accordingly, the low-lying areas of this type nearer the mouths of the rivers are, in general, the richest in organic matter and the organic content becomes less and less with the distance up the valleys, where also the area of this soil perceptibly decreases.

The Puget clay is a very superior soil for general farming, and is the most valuable one in the area. Probably three-fourths of its area is cleared, the native timber being mostly cedar and hemlock, with some spruce. The type is especially adapted to oats, and the yield on the delta flats ranges from 100 to 150 bushels per acre. This is the chief crop produced on the soil, and in view of the high yields a better adaptation could scarcely be suggested. Wheat likewise gives good yields, but the kernel is too soft for milling and liable to blacken, and but little of this grain is grown. Potatoes likewise yield well, from 300 to 400 bushels per acre, but are liable to scab. In other ways the quality is not quite so good as on some of the lighter soils of the area. The type is well adapted to the growing of hay and to pasture, and dairying is extensively practiced upon it. Timothy and clover or Italian rye grass yield from 3 to 4 tons of hay at a cutting, 2 to 3 cuttings being secured. The wetter areas and those subject to overflow are devoted mostly to pasture. Heavy crops of apples, pears, plums, and cherries are secured, but in most cases the trees observed were planted too close for best results. Cabbage, cauliflower, and the root crops develop well, and celery does well where the organic content is high. Where it is sufficiently drained the soil also produces large yields of berries—from 500 to 800 crates per acre. The varieties best adapted to this heavy soil are the Washington Evergreen dewberry, the Himalaya Giant, and Lucretia blackberries, and the Logan and Phenomenal crosses. The growth of the Cuthbert raspberry tends to be prolonged by the heavy texture, the Antwerp variety being not so much affected.

It will be seen from the foregoing paragraph that this soil has exceptional possibilities for the production of heavy yields of the staple farm products, excepting hard wheat. By its heavy texture and consequent large moisture capacity, as well as by the nearness of the water table to its surface, it is fitted to secure the heaviest yields and to be exempt from drought. The chief suggestion to be made as to its improvement is a more systematic drainage, according to the varying local conditions.

The land of this type of soil brings from $100 to $200 an acre, depending upon location and state of improvement. That such high prices are commanded is evidence of its great productiveness and of the ready markets for its produce.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Puget clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14073, 14075	Soil	0.2	2.4	0.6	1.5	3.2	58.0	33.8
14074, 14076	Subsoil	.1	1.0	.4	1.0	5.6	62.2	29.6

AGRICULTURAL METHODS.

The agricultural methods in use in the area have been developed with reference chiefly to the cool and rather dry character of the growing season. The coolness of the summers, together with the considerable proportion of fog and overcast weather, tends to compensate in a measure for the shortage in rainfall during the midseason. Grass and clover thrive remarkably well, even on light, sandy soils, because they are not burned out by hot summer suns. Italian rye grass seems to be preferred to timothy, giving somewhat larger yields of hay, besides affording excellent winter pasture. The most approved practice, however, s to keep the cattle off the grass

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system of culture in vogue for brambles, perfected by Mr. Littooy, reduces pruning to a minimum and emphasizes methods of training in accordance with the habits of growth of the different berries.

As a very special instance of the adaptation of methods to climatic conditions may be mentioned the culture of tomatoes[a] by pruning the plants so as to lie low on the ground and insure development of the fruit. Unless so pruned the plants suffer excessive growth from the coolness of the season, and the fruit buds shrink and fall off.

The climatic conditions in this area are also favorable to the special industries of bulb and cauliflower-seed production. Although they are not as yet grown in this area, experiments in adjoining counties have proved very promising for these specialties on soils rich in organic matter and somewhat similar in other ways to the Puget clay, the Puget silt loam, and the Puget fine sandy loam. They require very heavy fertilizing and the most careful intensive culture, but should prove worthy of trial on the soils mentioned.

In conclusion it is well to call attention to the decided advantages of the practice of subsoiling on such heavy soils as the Puget clay and the Snohomish silt loam. This not only serves to deepen the seed bed and increase the moisture supply, but is useful in breaking up the hardpan that tends at times to form on a soil like the Miami sandy loam from the cementing of its sandy and clay materials under the plow.

AGRICULTURAL CONDITIONS.

The farmers of this area, while as yet very limited in number, are generally in a prosperous condition. Although the initial cost of taking up and clearing land is high, most of them have already paid these obligations and have an exceptionally bright future. To achieve success in farming under local conditions, a certain degree of the pioneer spirit is necessary, which enables a man to bear the hardships of clearing and improving his land without discouragement in case the first few years do not bring him net returns. Under such circumstances a small amount of capital is desirable to support the farmer while he is clearing his land or, better, to enable him to have the land cleared and get returns from it from the start. This hardship must be undergone, and it is merely a question whether the business prospects are such as to justify it. On a great part of the soils of this area the farming prospects do justify it fully, and, as a matter of fact, many farmers have already received handsome returns from their investments. This is understood to apply in general to farmers who operate a small acreage more or less intensively.

Wages in the logging camps and sawmills here in the Northwest have, however, been so good that as yet but few laborers have been willing to consider farming, despite the fact that it offers some exceptional opportunities. About nine-tenths of the farmers own their own places, many of which were secured by homesteading or by taking up timber claims. There is, however, no land at present subject to entry in this area. A few tracts of land, mostly of Puget clay, are rented at from $6 to $8 an acre. These lands are, however, cleared and diked, and of exceptional fertility and advantageous location. They are generally rented with certain conditions as to maintaining dikes and making further clearings. In general, it is an easy matter to buy land on good terms from the land or logging companies. The agreement merely to do an amount of clearing is considered a fair guaranty for the future payment of the land, and a certain amount of logging or of cutting cedar bolts is thus generally involved in taking up the farm lands.

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[a] Littooy's "Tomato Culture."

The average size of the farms in the county lies somewhere between 80 and 100 acres, but the area actually under cultivation varies extremely on different soil types. In the valley soils—Puget clay and Puget silt loam—a large part of the farm is under cultivation to oats and hay and the rest is generally devoted to pasture, while in the upland soils hardly any area at all is cleared, and upon a farm of 80 acres only an acre or two can be found under cultivation—say potatoes, or perhaps several acres of lowlands devoted to pasturage—while the rest would be in timber.

The farm labor is very efficient, mostly German or Scandinavian, and commands good wages, averaging about $30 a month, with board in addition. During the harvesting of oats on the larger farms upon the Puget clay extra hands are secured from Seattle or Everett, and these are given wages of from $2 to $3 a day for that period. On account of the small acreage under cultivation in the uplands and the tendency toward intensive farming, few farm hands are employed. Indians of both sexes are employed to gather hops on some of the farms.

By far the most prominent industry in the area is lumbering, and numerous sawmills and shingle mills are in operation. The largest acreage of agricultural products is devoted to grass; the next largest to oats; the third to potatoes. A large amount of timothy, clover, or rye-grass hay is produced, but does not sell at as high a price as the more uniformly cured alfalfa hay from the eastern part of the State. Orchard grass and bluegrass and the red, white, and alsike clovers also grow vigorously and furnish excellent pasturage. Dairying is the most flourishing side of farming in the area, Snohomish County ranking second in the State in the value of its dairy products, and fully two-thirds of the farmers owe their success to this industry. Next to dairying and the production of hay, comes the growing of oats, which is the chief grain crop, and which constitutes the characteristic industry on the Puget clay. The acreage in wheat is small and the grain soft, the cool and moist climate being much more favorable to oats. The wheat produced is used for "chicken feed," or to adulterate the harder varieties in grinding flour. The climate is not suited to maturing corn, and the plants make excessive growth and fail to set developed ears. Sweet corn can, however, be grown to sufficient maturity to make good silage, and the more progressive farmers are growing it for the purpose. Stowells Evergreen variety has proved well adapted to this climate for silage purposes. The quality of table sweet corn is inferior. Potatoes are grown nearly everywhere with success, the yields being large and the quality good. Early Rose and Burbank potatoes are the most popular varieties. The root crops, such as ruta-bagas, parsnips, beets, and carrots, give large yields of fine quality where the moisture supply is adequate. Cauliflower, cabbage, celery, rhubarb, and peas likewise make a strong growth, the climatic conditions being especially suited to cauliflower and cabbage when grown on the heavier soils. Tomatoes, however, on account of the cool climate, tend to run all to leaf and set fruit poorly unless pruned. On the heavy soils orchards of apples, pears, plums, and cherries give large yields of good fruit. Peaches do not mature and color well, and grapes are successful only in a few favored locations near the water. Small fruits do exceptionally well on the valley soils, and the berries from the Snohomish Valley are of very superior size and quality, and are shipped considerable distances east.

The adaptation of different soils to different crops has been recognized in quite a specific way in the case of several crops in the area. For example, Puget clay is recognized as adapted to oats, its heavy texture insuring an adequate moisture supply during a long growing season. The Puget silt loam is recognized as best adapted to hops in that it gives good yields, and yet without sacrificing the quality of the hops. The lighter upland soils are utilized for growing early crops of potatoes and early garden produce, their lower moisture supply and higher temperature serving to hasten the maturity of the crops. The adaptation of varieties of berries to the different valley soils has been carefully superintended by Mr. Littooy, with the result that the erect growing varieties of brambles—the Cuthbert and Antwerp raspberries, the Snyder, Lawton, and Kittatinny blackberries—are utilized for planting on the Puget silt loam, while the vinous varieties—the Washington Evergreen dewberry, the Himalaya Giant and Lucretia blackberries, and the Logan and Phenomenal crosses—are selected for the heavier Puget clay.

The transportation facilities of the area are exceptionally good, the main line of the Great Northern Railway entering near Monroe and terminating at Everett, while the coast-line branch of the same

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square miles): One soil map.

Soil Survey of the Biloxi Area, Mi
One soil map. By W. Edward

Soil Survey of the De Soto Paris
Grove B. Jones and La Mott R

Soil Survey of Anderson County, Texas (1,069 square miles): One soil map. By William T. Carter, jr., and A. E. Kocher.

Soil Survey of the Austin Area, Texas (parts of Bastrop, Caldwell, Hays, Travis, and Williamson counties, 705 square miles): One soil map. By A. W. Mangum and H. L. Belden.

Soil Survey of the San Antonio Area, Texas (part of Bexar County, 484 square miles): One soil map. By Thomas A. Caine and W. S. Lyman.

Soil Survey of Lawrence County, Tennessee (618 square miles): One soil map. By Charles N. Mooney and O. L. Ayrs.

Soil Survey of the Greeneville Area, Tennessee-North Carolina (parts of Greene, Hawkins, Cocke, and Sullivan counties, Tenn., and Madison County, N. C., 664 square miles): One soil map. By Charles N. Mooney and O. L. Ayrs.

Soil Survey of Warren County, Kentucky (533 square miles): One soil map. By Thomas D. Rice and W. J. Geib.

Soil Survey of Wooster Area, Ohio (parts of Wayne, Stark, and Summit counties, 469 square miles): One soil map. By Thomas A. Caine and W. S. Lyman.

Soil Survey of Coshocton County, Ohio (551 square miles): One soil map. By Thomas D. Rice and W. J. Geib.

Soil Survey of the Munising Area, Michigan (part of Alger County, 407 square miles): One soil map. By Thomas D. Rice and W. J. Geib.

Soil Survey of the Saginaw Area, Michigan (parts of Saginaw, Bay, Tuscola, and Huron counties, 984 square miles): One soil map. By W. E. McLendon and M. Earl Carr.

Soil Survey of the Alma Area, Michigan (part of Gratiot County, 283 square miles): One soil map. By W. Edward Hearn and A. M. Griffen.

Soil Survey of the Owosso Area, Michigan (part of Shiawassee County, 270 square miles): One soil map. By A. W. Mangum and Charles J. Mann.

Soil Survey of Marshall County, Indiana (445 square miles): One soil map. By Frank Bennett and Charles W. Ely.

Soil Survey of Scott County, Indiana (197 square miles): One soil map. By A. W. Mangum and N. P. Neill.

Soil Survey of the Boonville Area, Indiana (parts of Warrick and Spencer counties, 264 square miles): One soil map. By A. W. Mangum and N. P. Neill.

Soil Survey of the Superior Area, Wisconsin-Minnesota (parts of Douglas County, Wis., and St. Louis County, Minn., 483 square miles): One soil map. By Thomas A. Caine and W. S. Lyman.

Soil Survey of Tama County, Iowa (720 square miles): One soil map. By Charles W. Ely, George N. Coffey, and A. M. Griffen.

Soil Survey of Saline County, Missouri (748 square miles): One soil map. By M. Earl Carr and H. L. Belden.

Soil Survey of the O'Fallon Area, Missouri-Illinois (parts of Lincoln, St. Charles, and St. Louis counties, Mo., and Calhoun County, Ill., 620 square miles): One soil map. By Elmer O. Fippin and J. A. Drake.

Soil Survey of Webster County, Missouri (605 square miles): One soil map. By J. A. Drake and A. T. Strahorn.

Soil Survey of the Kearney Area, Nebraska (parts of Dawson, Buffalo, Phelps, Kearney, and Gosper counties, 792 square miles): One soil map, 1 alkali map (colored plate). By J. O. Martin and A. T. Sweet.

Soil Survey of Allen County, Kansas (504 square miles): One soil map. By J. A. Drake and W. E. Tharp.

Soil Survey of the Garden City Area, Kansas (parts of Finney and Gray counties, 336 square miles): One soil map. By James L. Burgess and George N. Coffey.

Soil Survey of the Cando Area, North Dakota (part of Towner County, 283 square miles): One soil map. By Elmer O. Fippin and James L. Burgess.

Soil Survey of the Greeley Area, Colorado (parts of Weld and Larimer counties, 687 square miles): One soil map. By J. Garnett Holmes and N. P. Neill.

Soil Survey of the Bear River Area, Utah (part of Box Elder County, 334 square miles): One soil map, 1 alkali map, 1 underground water map. By Charles A. Jensen and A. T. Strahorn.

Soil Survey of the Yuma Area, Arizona-California (parts of Yuma County, Ariz., and San Diego County, Cal., 340 square miles): One soil map, 1 alkali map. By J. Gar-